Pensions, Work and Informality. A Multi-Tier Contributory Pension System

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I, Andres Otero confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

This thesis studies the relationship between pension incentives and formal labour market participation in a multi-tier defined contribution pension system. During 2008 a mayor pension reform was implemented in Chile, changing simultaneously the redistributive welfare and contributory tier of the system, introducing several elements to boost formal labour market participation and reduce inequalities. The expected pension wealth at retirement and the accrual rate have differently changed for different group of the population due to the reform.

I estimate the effects of the reform on formal labour market participation using two different empirical strategies: First, I use a difference in difference estimator to address the effect of the expected pension wealth on formal labour market participation. I exploit the differential effects of the reform on individuals belonging to different groups to gain identification. The endogenous pension wealth is instrumentalized using time and group dummies. Second, I solve and estimate a dynamic consumption, labour supply and pension savings accumulation life cycle structural model. It complements the existing literature by incorporating the choice of two sectors in the labour market, the formal and informal labour sectors and by allowing for intrahousehold bargaining power. Households choose individuals' sector labour supply and consumption in an environment with uncertainty given by sectoral wage shocks, future marital status and future fertility choices.

The main results of the thesis are threefold. Firstly, the changes in the final pension wealth at retirement and the accrual rate have reduced formal labour market participation. Secondly, the reform has increased not only the self-financed pension wealth but also has importantly improved the final pension due to the first tier reform. Finally, even though the final pension changes have been positive for both gender, the female pension improvement has been much higher

than the rise for men reducing the gender inequalities.

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1 Introduction

Informality leaves workers unprotected against employment-related shocks and old-age poverty. A large fraction of employees working informally has historically been a major issue across developing countries; with informal employment composing 56% of urban jobs in Latin America in 2007 (Perry et al. [2007]). Generous pension systems can reduce individuals' formal labour market participation, eventually affecting their pension income at retirement in systems in which both are structurally related. On the other hand, most systems, other than simple individual savings have a *de facto* redistributive role. Indeed many systems are designed with such redistribution in mind. The issue of how to implement a welfare tier structure without increasing informality but tackling inequality is an open empirical question. This thesis studies the relationship between pension incentives and informal labour market participation. During 2008 a mayor pension reform was introduced in Chile changing simultaneously the redistributive welfare and contributory tier of the system and introducing several elements to boost formal labour market participation and reduce inequalities. The expected pension wealth at retirement and the accrual rate[1] have differently changed for different group of the population due to the reform. I estimate the effects of the reform on the labour market participation using two different empirical strategies: First, I use a difference in difference estimator to address the effect of the expected pension wealth on formal labour market participation. I exploit the differential effects of the reform on individuals belonging to several year-of-birth cohorts and different groups to gain identification. The endogenous pension wealth is instrumentalized using time and group dummies. Second, I solve and estimate a dynamic consumption, labour supply and pension savings accumulation life cycle structural model. It complements the existing literature by incorporating the choice of two sectors in

[1]Defined as the rate of conversion of an additional dollar in future pension benefits.

the labour market, the formal and informal labour sectors and by allowing for intrahousehold bargaining power. Households choose individuals' sector labour supply and consumption in an environment with uncertainty given by sectoral wage shocks, future marital status and future fertility choices. The model enables workers to borrow against non-pension savings, considering current and future intrahousehold allocation in consumption and labour supply and future possibilities to divorce, marriage and the birth of more children.

Two main differing views have been put forward as possible explanations for informality. Firstly, workers allocate themselves in each sector according to their preferences and to sectoral wages and benefits (Piggot et al. [2008], Meghir et al. [2012]). Secondly, informality has been understood as a residual sector coming from a segmented formal market (Magnac [1991], Cahuc and Postel-Vinay [2002]) as a result of structural economic constraints, such as a minimum wage legislation and other protection labour laws. The easier it is to move from the formal to the informal sector, the larger the potential effects on formal labour market participation are due to a new legislation. For instance, additional pension benefits will change the informal labour market participation depending on how easy it is for the workers to move from the informal sector to the formal one. The lack of barriers to entry to the formal labour market increases the effects on the pension system's coverage, and eventually fiscal expenditures, when new additional pension benefits are introduced.[2]

I define formality according to the participation in the pension system, considering an employee as working in the formal sector at period t if she is contributing to the pension system at year t. The term informality has different meaning for different people in different places. It is usually related

[2]To date, the empirical evidence about which view prevails is mixed (Contreras and Puentes [2009], Maloney [1999], Meghir et al. [2012], Joubert [2012]).

with several concepts such as: excessive regulation, low productivity, evasion of the rule, underpayment or nonpayment of taxes and unprotected workers. Even though these concepts are commonly linked, it is not possible to have just one definition of informality capturing all of them. In this sense, the final chosen definition is given by the subject to be studied.

Pension systems aim mainly to guarantee a stable level of consumption upon retirement and in some cases play an explicitly distributive role. Different systems generate different incentives to work either in the formal or informal sector market and convey different redistributional mechanisms. Defined contribution (DC henceforth) pension systems operate through individual contributions made during one's working lifetime in order to finance future pensions. They have been broadly implemented in Latin America[3] in the 1980s and 1990s. Pay-as-you-go (PAYG henceforth) systems, in turn, finance individuals' retirement with current workers' taxes. As the number of pensioners per worker have risen due to longer life expectancy and lower fertility rates, many European countries and The United States have been discussing reforming their PAYG systems, noting the DC system as a possible candidate. However, even though the DC systems seem the appropriate option instead of the financially unbalanced PAYG systems, they have not accomplished the expected coverage and replacement rates[4] (Auerbach et al. [2007], Attanasio et al. [2012a]). This has increased the need for govern-

[3]Since 1990, several countries have implemented a capitalization system, as a DC system is sometimes called: Argentina (1994), Bolivia (1997), Colombia (1993), Costa Rica (1995), Dominican Republic (2003), El Salvador (1998), Mexico (1997), Panama (2008), Peru (1993), Uruguay (1996) and Slovakia (2005).

[4]Replacement rate is defined as the fraction between the pension income over some measure of pre-retirement income, such as the average life cycle wage.

ment expenditure in the same way that PAYG systems have required net government transfer to cover their revenue shortfalls as the population ages. On the other hand, individuals with low labour market attachment, such as women and poor people, contribute to the system sporadically, eventually retiring with low pensions and facing old-age poverty. Moreover, DC systems have tended to replicate the labour market inequalities and to avoid inter-generational redistribution.

1.1 Chilean Defined Contribution Pension System.

In the early 1980s, Chile reformed its public pension system and instituted a mandatory DC pension system that combines its core contributory structure with both a welfare pillar orientated to the poorer population and a voluntary pillar aimed to top-up individuals' contributions. Several reasons were provided in argument for replacing the existing PAYG system. 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 a labour 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 (PFA 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 vast; 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 average replacement rates: 28% for women and 51% for men in 2005.[5] The main reason behind these ex-post low-average replacement rates seems to be that many individuals do not contribute frequently enough to the system. After more than 30 years since its implementation, the low frequency of contributions appears as one of the main problems in the system, which is particularly serious for groups with low labour 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 (CRP [2006]), reflecting one of the features of the Chilean labour market, namely its low female labour participation. This lower female labour attachment, together with lower female wages and longer female life expectancy have generated an important gender gap and much higher prevalence of poverty and hardship among female elderly.

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 labour market characteristics prevailing in the periods preceding the reform in 1981. However, Chile has experienced important demographic and socioeconomic changes in the last

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

three 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 labour market participation jumped from 29% in 1986 to 37% in 2005, decreasing the average number of contributions due to the fertility decisions made by women. The fraction of employees working under temporary labour 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 labour histories.

The current Chilean pension system is referred to as a three-tier System, because its main DC component comes on top of a basic pension and on the bottom of a voluntary savings component. The Chilean pension arrangements are a good example of a system designed to be in part funded and also to include a taxpayer-subsidized redistributive element offering a safety net for poorer individuals who either have not worked and saved enough over their working life or have worked in mainly informal jobs and have not contributed to the system. The second tier, sometimes called the core 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 compulsory monthly contributions[6] of 10%, which is saved in the individual accounts. These savings are man-

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

aged by a private PFA, chosen by each worker, which invests the funds in the national and international financial market until the worker decides to retire. As of October 2002, workers can choose among five funds with different combinations of risk and return. When workers do not choose any particular 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 instruments to be chosen and on the proportion of foreign investments done. FPAs charge an additional variable fee of 2%, which is used to cover the administration costs and to 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.[7] At the legal age of retirement[8], 65 for men and 60 for women, individuals can withdraw from the labour force and start to receive a pension. Individuals can continue working and contributing to 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 and individual accumulated funds could be withdrawn. Retirees can choose mainly between two pension modalities, either a scheduled withdrawal scheme, which is paid until funds run out, or an annuity scheme. Regarding the former, the accumulated resources are still managed by the

[7]This in turn results in low pension benefits. Final Report, 2006 Pension Reform Commission. CRP [2006]

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

PFAs and invested in the financial market during retirement. The annuities are provided by insurance companies on payment of the individual's capital.[9]

The pension income at retirement, therefore, depends primarily on the amount saved during the life cycle and upon 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 during the periods near retirement. Consequently, individuals who 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. This has implied low replacement rates and important inequalities as the system tends to replicate the labour market differences.

In addition to the mandatory second tier, the pension system, before 2008, also had a dual-component redistributive first tier composed of the following:

- A contributory minimum pension, "Pension Minima Garantizada." To be eligible for the PMG, the individual should have contributed to the pension system's second tier for at least 240 months and should not be able to self-finance the PMG with her accumulated pension contri-

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

butions. In 2008, the PMG was CLP$ 96,390 (US$ 212).[10] Therefore, individuals with less attachment to the formal labour 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 of 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-month requirement needed for receiving it (Berstein et al. [2005]).

- A means-tested welfare pension, "Pension Asistencial". 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 to a poverty indicator, and it has been usually given to retirees belonging to the poorest quantile. In 2008, the PASIS was CLP$ 54,091 (US$ 119) 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 Ficha de Proteccion Social (FPS). This indicator, used for allocating both the PASIS and the new welfare pensions implemented by the reform, is determined by taking into account a complete set of socioeconomic household characteristics, such as incomes, household size and its composition, health and years of education.[11]

[10]The exchange rate Chilean Pesos to American Dollars for October 2012 is CLP$ 1 = US$ 0.0022.

[11]Modifications to the FPS indicator were introduced during 2011 in order to allow for a better measure of 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 savings are excluded from taxable income[12] (ETT), being all taxes paid at retirement, and from the self-financed pension wealth used to determine eligibility for the welfare first-tier pensions.

1.2 2008 Chilean Pension Reform.

In 2008, a major pension reform was implemented to tackle the main problems of the pension system, specifically those related with low attachment to the formal labour market and, consequently, low frequency of contributions. In this sense, the reform aimed to increase participation in the pension system, to reduce inequalities generated by the DC scheme, to prevent old-age poverty, to guarantee a minimum and stable level of consumption upon retirement, and to increase the welfare of women. The reform involves several changes to the current system. First, two new components were introduced in the welfare tier: a flat non-contributory welfare pension (PBS hereafter) intended to alleviate poverty for those not entitled to a second-tier benefit and a welfare pension complement (APS hereafter), intended to sustain consumption by topping-up the self-funded second-tier pension. Second, different components to recognize the disadvantages generated by the structure of the system, in particular among groups whose attachment has been tra-

[12]For monthly amounts below CLP$ 1,050,000 (US$ 2310) at 2009, adjusted annually according inflation.

ditionally infrequent and/or irregular. Women, young workers, and the self-employed were the explicit target of these incentives. These new elements of the reform were aimed at fostering participation in the contributory and voluntary pillar. They include a children subsidy obtained by every mother, contributions to the pension system are subsidized for each child they have; compensation upon divorce, there is now a pension savings compensation upon divorce in favour of the worse-off member of the couple; male survivor pensions, women will have to provide pension funds to leave a survivor pension benefit to her husband and gender-dependent survival pension premium rates.

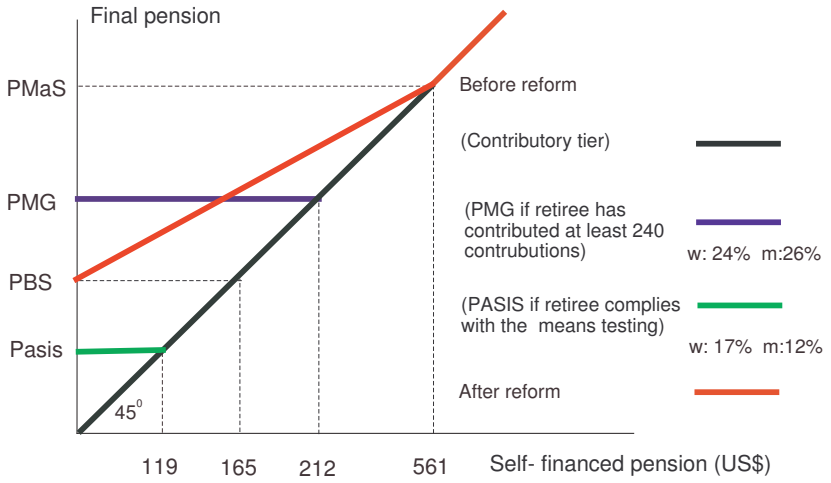
As for young workers, they get a subsidy both to their wage, through the employer, and to their contributions. The reform enables the self-employed to be eligible for the benefits in the first tier and obliges them to participate in the pension system.[13] Lastly, new voluntary occupational saving plans and new tax exemption schemes are introduced in the third tier.

The pre- and post-reform schemes are shown in Figure 1. The 45-degree line represents the pure DC system in which self-saved pension wealth (horizontal axis) becomes a final pension (vertical axis) upon retirement. Before reform, the green and blue lines represent either the means-tested PASIS or the contributory PMG pension. After the reform, the red line shows the minimum non-contributory pension, PBS, which is topped-up by the APS subsidy. In this sense, the reform sets up a more comprehensive system in which the redistributive and the mandatory tiers of the system are integrated

[13]From 2012 to 2014, the self-employed participate voluntarily in the system, but they have to explicitly opt out to avoid participation. Starting in 2015, participation will be compulsory and contributions will be done over 80% of gross earnings.

with each other. The reform costs annually around 1.1% of GDP[14], being one the largest of the Chilean social reforms in recent years.

Figure 1: Multi-Tier System Structure



As I explained, workers contribute to the pension system, accumulating pension wealth into individual accounts to self-finance future pensions upon retirement. Therefore, individuals accrue pension wealth each period according to their contributed wages and the associated earned returns for those contributions. This accrual mechanism, combined with the welfare elements of the system, generates particular incentives to contribute to the system and then work formally. Importantly, the pension reform changes the expected pension at retirement and the accrual rate through both the new welfare tier in place and through the various mechanisms introduced to complement the

[14]According to forecasts by the Chilean Pension Regulator, "Superintendencia de Pensiones" (SPE), and the Budget Office, "Direccion de Presupuesto" (DIPRES). See CRP [2006] in the references.

contributory tier. The change in the expected pension wealth at retirement and the change in the expected accrual rate can be understood as an income and substitution effect on the labour supply choices, respectively. These changes are different for different groups of the population, not only because some of the new incentives are explicitly targeted to specific groups, but also because the younger cohorts have more time to react optimally to the reform. Most individuals will experience both income and substitution effects as a consequence of the reform. The former will typically decrease the propensity to participate in the formal labour market, while the latter can go both ways, depending on whether, for a specific individual, the rate of conversion of participation in future pension benefits (the accrual rate) increases or decreases. Therefore, from a theoretical point of view, the reform has an ambiguous effect on participation in the formal labour market. The individual effects on the labour market depend on the worker's pre-reform situation and how the final pension and accrual rate change due to the reform. When aggregating the income and the substitution effect, it is possible to determine the total empirical effect on the individual formal labour market participation due to the reform. Moreover, the aggregate final effect will depend on how workers are distributed across the Figure 1 budget constraint.

1.3 Elements of the reform to be evaluated.

Probably the largest change introduced by the 2008 reform is the reform to the first-tier system. The PMG and the PASIS are now substituted by the PBS and the APS. The PBS welfare pension was started on July 1, 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 was gradually increased each year until 2012, when it reached the poorest 60% of the elderly population. The PBS is a flat non-contributory pension set at CLP$ 60,000 (US$ 132) for 2008 and increasing to CLP$ 75,000 (US$ 165) from 2009. This new welfare pension could be understood as the minimum floor income that any retiree older than 65 years old, who belongs to the 60% poorest population will receive. The reform eliminates the number of contributions as one of the eligibility conditions for receiving a minimum pension.

The APS welfare pension complement, also started on July 1, 2008, intends to sustain consumption by topping-up the funded second-tier pensions between the PBS and a maximum-funded pension, PMAS, which was increased gradually[15] until it reached the value of CLP$ 255,000 (US$ 561) in 2012. The APS is decreasing in the funded pension and does not have, in the same way as the PBS, a minimum contribution-period 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 previous 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. These changes are illustrated in Figure 1 as shown in Section 1.2. Before the reform, retirees at the bottom of the distribution (of second-tier

[15]The main features of the two new components of the redistributive tier are summarized in Table 1.

pension benefits) could be divided into three groups: (i) those who received their funded pension (the 45-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), and (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.[16] The latter group is constituted by those who satisfied the 240-month contribution requirement and had not enough entitlements in the second tier to self-finance a final pension of CLP$ 75,000 (US$ 165); under the new system, the PBS, while higher than their self-financed pension, is below the PMG.

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

- A subsidy for every child ever born to the mother (implemented since July 1, 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

[16]Workers older than 50 years old in 2008 will receive the higher pension, eith561er the PMG or the post-reform pension.

at the time of birth of every child.[17] Subsidies earn returns since the date of birth of the child until the date of retirement or from July 2009 until retirement in cases in which 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 childbearing periods, reducing gender inequality in pensions. Furthermore, this generates incentives to participate in the formal labour market, as it is required to be affiliated to the pension system in order to receive the subsidy.

- Around 2% percent of the individual mandatory monthly contribution is used for financing survivor and disability insurance for each affiliate. Even though the risks of death and illness have been historically lower for women than for men, the system has not recognized this fact, charging a common premium rate. Since July 1, 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 through which all FPAs bid for managing the insurance. FPAs could offer different rates for men and women, thus recognizing the difference in their risks. Both groups will be charged with the higher offered rate, but the difference will be incorporated in the individual accounts for women as part of their contribution.

- Before October 1, 2008, survivor pensions were received just by wives; this has been changed by the reform incorporating a survivor pension

[17] In 2009, it was equivalent to CLP$ 286,200 (US$ 630).

benefit to the husband as well. On the other hand, the reform introduced a possible compensation upon divorce in favour of the worse-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.[18]

[18]Table 1 summarize the main elements to be evaluated through the thesis.

Table 1: 2008 Chilean Reform Structure

2008 CHILEAN PENSION REFORM

NEW ELEMENTS	AIM	BENEFITS	REQUIREMENTS
I. Subsidiary Tier			
Welfare basic pension (PBS). 1st July 2008.	To alleviate old age poverty	Flat pension of CLP $60000. It will increases to CLP$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=CLP$0.0022, PMaS is the maximum pension such as one receives government pension complement. Its value is CLP$70000 in 2008; CLP$120000 in 2009; CLP$150000 in 2010; CLP$200000 in 2011; CLP$255000 in 2012.

SUMMARY OF THE CHILEAN PENSION REFORM 2008

NEW ELEMENTS	AIM	BENEFITS	REQUIREMENTS
II. Compulsory Contributing Tier			
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 CLP$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 partner´s accumulated funds.	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.

The changes introduced to the welfare pensions, such as the replacement of PMG and PASIS with the PBS and the APS have changed substantially the final pensions and the accrual rates. As it is clear from Figure 1, different individuals experience different changes on their accrual rates. For instance, an individual who was receiving the PMG before the reform, and then facing a zero-accrual rate over a large region of her contributions, will face a positive accrual rate after the reform, represented by the slope of the red line in Figure 1. On the other hand, an individual who was on the 45-degree line to the left of CLP$255,000 (for instance, the wife of a relatively well-off husband − who therefore did not qualify for PASIS − and who has relatively low attachment to the labour market so that she had less than 240 months of contribution) would now receive the PBS supplement and would have the accrual rate relative to the post-reform situation. Needless to say, these changes to accrual rates are also accompanied by changes to the level of pension wealth. These changes differ among individuals depending on their initial situation previous to the reform. Worker with low labour market attachment will face different accrual rate and pension wealth changes due to the reform than those workers with stable labour situations. Therefore, the reform will affect labour market participation differently for these groups.

There are several other elements incorporated in the 2008 reform which I am not evaluating. These components target different groups, such as young employees and the self-employed, starting on different dates (some of them were active just after the last observed period in the data) and include some general modifications 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 complete list is described in the next section.

1.4 Other components introduced by the reform.

- 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. From 2012 to 2014, default-voluntary participation is introduced, in which workers have to explicitly decide not to participate in the system. For the years 2012 and 2013 contributions will be made 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 onward.

- Subsidy for young people's contributions. From the 1^{st} of July 2011, employees between 18 and 35 years old who earn a salary less than 1.5 times the minimum wage receive a subsidy for all of 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, and then they will be

active after the last observed period in the data, I do not expect an importantly current effect on the observed labour market data 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.[19]

- Subsidy for voluntary contributions. From the $1^{st}$of October 2008, the third tier of the system is subsidied 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 15% of the entire saved amount[20]. In September 2010, the number of voluntary contributions operating with this new tax regime was 7% of the total voluntary number of contributions.[21]

[19]Two additional programs focused on the young workers (18-24 years old), Subsidio al Empleo Juvenil and Jovenes Bicentenario, were implemented around the same time of the reform implementation. Their benefits are larger (and exclusive) than the ones associated with the subsidy for hiring young people introduced by the reform. Therefore, most of the employers have chosen the former ones.

[20]With a maximum of CLP$ 221,178 (US$ 487) in 2009. These values will be readjusted each year according to the inflation.

[21]According to the Regulator, Superintendencia de Pensiones de Chile.

- 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 to their employees accounts, as those contributions are considered to be the company's expenditures and therefore do not pay taxes. Employees will not only get the subsidy given by the employer but also can get all of the available benefits for voluntary savings described above. Even though this element has been operating for the past four years, the number of collective voluntary saving plans has been minor according to regulator information. Therefore, I do not expect any important effect on the labour 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 affiliate portfolio. Affiliates can choose another FPA after 24 months of the original auction. This new mechanism aims to generate more competition in the system, thus reducing the charged fees.

Before describing the pension entitlements used to estimate the reform's impact, I briefly discuss the used data in the next subsection.

1.5 Data.

In evaluating the pension reform, I will use two sources of data that will complement each other: the Social Protection Survey (Encuesta de Protección Social, EPS) and the Chilean Pension System Administrative Records. The EPS is a panel data nation-wide survey containing a rich set of information about Chilean households and their participation in the labour market and the social security system. The EPS was the first attempt to built it up a panel data survey in Latin America and the first systematic effort to collect household data about the Chilean pension system. See Arenas et al. [2006] for a complete description about the aims and the relevance of the EPS. It was initiated in 2002 and followed up during years 2004, 2006, and 2009, which provides me data before and after the reform. In particular, I will use the information on job and contribution histories, assets, 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 me with monthly earnings, contributions, fees paid, and accumulated pension savings.

As was explained before, the two new elements of the first tier are means tested and are targeted to the 60% poorest of the population of those 65+ years old. This target group is defined by the FPS poverty indicator (Ficha de Protection Social, FPS). This indicator, used for allocating the PASIS and the new welfare pensions implemented by the reform, is determined by taking into account a complete set of socioeconomic household characteristics

such as permanent incomes, household size and composition, health status and years of education. However, in 2011, the FPS was changed, and a new instrument, called Instrumento Tecnico de Focalizacion (ITF), was introduced for means testing.[22] In general terms, both indicators are similar but they use different sources of data and weigh differently individuals within the household according to age. To evaluate the redistributive elements of the pension reform, one must identify the individuals in the EPS that belong to the eligible group at retirement. As there is not available information about the FPS for all the EPS interviews, I use an estimation of the ITF score to allocate the welfare pensions. The ITF was computed using the self-reported incomes in the survey. As I aim to unveil the effects of the reform on the labour market participation before retirement, I only use information about non-retired AFP affiliates who are younger than 65 and older than 20 in all of the EPS waves.[23] Table 2 shows some descriptives for the used data.

[22]Detailed information about this new indicator, including its formula, can be found in "Decreto Supremo N. 2, and Resolucion N. 155 and N. 164. Superintendencia de Pensiones (SPE), Ministry of Work".

[23]As I mentioned earlier, it is possible to continue working after the legal age of retirement. However, I am not considering those individuals who continued working after 65 and, for simplicity, I will assume that all employees retire at the age of 65.

Table 2: Descriptives

Descriptives - Year 2009

Variables	Men	Women
Observations	4793	3994
Average Age	45	44
Average Formality (Yes=1)	0.54	0.39
Percapita Household Income*	CLP$114,759	CLP$103,427
Finished Primary (Yes=1)	0.41	0.36
Finished Secondary (Yes=1)	0.21	0.24
Finished College (Yes=1)	0.21	0.28

*Monthly value. Household Income includes all self-reported labor incomes, governmental subsidies, pensions and rents from the EPS2009. CLP$1=US$ 0.0022 at 2012

1.6 Pension entitlements.

As the expected pension wealth and the accrual rate will be crucial in my future estimations, it is important to show explicitly how they are computed under the pre and post reform scenarios. Hereafter I will distinguish between pension wealth and pension. The former refers to the self-saved accumulated resources into the individual accounts and the later refers to the final pension financed with the pension wealth. The pension wealth turns on a pension according to, among other things, the welfare tier structure. The present value[24] of the expected accumulated pension wealth upon retirement (R) in

[24]To make the things simpler I am not writing the discount factor, which is assumed to be equal to 0.98, in the following formulas.

periods $t = \{2002, .., 2009\}$ is computed for each individual i as

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

$$+ \sum_{j=t+1}^{R} (cont_{ij}) \prod_{j}^{R}(1 + r_j)] + WE_{ij} + RB_{iR} \quad (1)$$

The first sum is the total observed accumulated pension until period t. The elements following the expectation incorporated the unobserved future returns earned for the contributions made before t and all of the future contributions and their own returns until retirement R. WE_{ij} captures the new forecasted elements introduced by the reform, such as the child subsidy and compensation upon divorce, $cont_{ij}$ is the annual contribution described below, r is the interest rate earned by the accumulated resources. Workers can choose among 5 funds with different combinations of risk and return. When workers do not choose any funds their savings are invested among three default funds defined by age. I assume different interest rates by age according to the default multifunds structure. Female younger workers between 18 and 35 years old have the riskier default fund, named B. Female workers between 36 and 50 years old and 51 and 65 years old are allocated to less riskier default funds C and D, respectively.[25] As age increases, the funds' risk decreases. Fund B, C and D returns are assumed to be equal to 11%, 9% and 7%, respectively. These choices are consistent with the average return of the last 20 years of the Chilean DC system, which has been around 9%

[25]The age thresholds defining the default funds are gender dependent. Male workers between 36 and 55 years old and 56 years old onward are allocated to default funds C and D, respectively.

(CRP [2006]). In particular, I observe whether workers have chosen a specific fund in the year 2009; for these cases I assume that individuals will hold the same fund for all remaining ages defining the current workers' default fund. RB_{iR} (recognition bond) is an financial instrument created and issued by the Government for capturing any old contributions to the PAYG system.[26]

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

Where $\imath$ is an indicator function taking the value of 1 if the expression in the brackets is true and $W^F$and W^E take the value of 1 if individual i is a formal worker and employee, respectively.

$$WE_{ij} = \lambda_i \times CA_{td} \prod_{j=td}^{R}(1+r_j)\imath[Woff] - \lambda_i \times \sum_{j=0}^{td}(cont_{ij}) \prod_{j}^{R}(1+r_j)\imath[Boff] + \tag{2}$$

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

The first two terms in equation (2) are the compensation upon divorce introduced by the reform. Family courts will determine if one of the members must be compensated, in which case she will receive a fraction λ_i of her partner's accumulated resources, CA_{td}, when divorce happens at period $j =$

[26]I observe the RB value for those affiliates who have claimed it. However, for affiliates who have not claimed the recognition bond, I assume their values according to groups defined by education, age and cohort groups.

td.[27] Woff (Boff) takes the value of 1 if individual i is considered by the court as the worse(better)-off member. The final summation includes all of the subsidies received for each child. Where MW is the minimum wage at period tb[28], Tc is the total number of children, $tb(nc)$[29] 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 self-financed pension wealth I compute pensions according the following formulas in the pre and post-reform scenario, respectively.

Pre-reform pensions are computed considering the cases when retirees receive either a PMG or the PASIS at retirement.

$$P_{iR} = \begin{cases} PASIS & \text{if} \quad \frac{E_t PW_{iR}}{12 \times CNU_{iR}} < PASIS \\ & and \quad i \in 10\% \quad poorest \\ PMG & if \quad \frac{E_t PW_{iR}}{12 \times CNU_{iR}} < PMG \\ & and \quad \sum^t \imath[W^F] >= 20 \\ \dfrac{E_t PW_{iR}}{12 \times CNU_{iR}} & Otherwise \end{cases} \tag{3}$$

Retirees self-finance pensions according to the accumulated pension wealth under the non-reform scenario, receive a PMG if the pension 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 self-financed pension

[27] Compensation upon divorce is for divorces after 2008 only.
[28] I am assuming a rate of growth of 3% for the minimum wage in all future periods.
[29] For children born before the reform, the bond receives returns since 2008.

is lower than this value and the means tested requirement is satisfied.[30] The CNU_{iR} is a factor that incorporates the individual's life expectancy.[31]

Pensions after the reform are determined by the following structure:

$$P_{iR} = \begin{cases} PBS & \text{if} \quad \frac{E_t PW_{iR}}{12 \times CNU_{iR}} = 0 \\ & and \quad i \in 60\% \quad poorest \\ \frac{E_t PW_{iR}}{12 \times CNU_{iR}} + (PBS - \frac{PBS}{PMaS} \times PB_{iR}) & if \quad 0 < \frac{E_t PW_{iR}}{12 \times CNU_{iR}} \leq PMaS \\ & and \quad i \in 60\% \quad poorest \\ \frac{E_t PW_{iR}}{12 \times CNU_{iR}} & if \quad PMas < \frac{E_t PW_{iR}}{(12 \times CNU_{iR})} \\ & or \quad i \in 40\% \quad richest \end{cases} \tag{4}$$

Where PBS is the new non-contributory welfare pension, $PMaS$ is an upper-limit pension[32] 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 survivor pension and any pension received from the past PAYG system.

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

[31]All of 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 is the relevant interest rate used to compute phased withdrawals (Norma 79, Ministerio del Trabajo y Planificacion Social de Chile), which is assumed equal to 4.5%. If the retiree has potential survivors, the final retiree's CNU is the sum of the survivors' CNU and his ownCNU.

[32]The PBS pension is readjusted annually according to inflation. I am assuming an annual rate of growth of 3%.

2 A Reduced Form Approach Evaluation

This section estimates the impact of the 2008 Chilean pension reform over the labour market focusing mainly on female labour market participation and pensions at retirement. In particular, I 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 labour market participation. In doing so, I will follow the approach used by Attanasio and Rodhwedder [2003] and Attanasio and Brugiavini [2003], who estimate the substitution effect on saving rates 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. I will estimate the relationship between pension wealth/accrual rate and participation rates to the formal and informal labour market.

The main results of this section are twofold. Firstly, the changes in the final pension wealth at retirement and the accrual rate have reduced formal labour market participation. The probability to contribute to pension system has decreased as a result of the reform, reducing the participation in the formal labour market by around 4.1% for those workers older than 40 years old. The results differ by gender and age. The reform reduces the probability of being formal by 3.2% and 2.8% for women and men between 56 and 65 years old, respectively. Secondly, 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 by 0.6% and 15%, respectively. Even though the final pension changes have been positive for both gender, the female pension improvement has been 56% higher than the rise for men reducing importantly the gender inequalities. On the other hand, there are several outcomes of interest that I have analyzed, such as the effect of the reform on the poverty levels or the effect of having an additional child on labour market participation after the reform.

2.1 Methodology.

The nature of the pension system is likely to affect labour market decisions. In its simplest form, the life-cycle model predicts that the expected future income affects the incentives to participate in the labour 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 labour market. For example, while before the reform poor informal workers receiving the PASIS 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 as they would get the APS. 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 incentives throughout

the labour 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.

Both, the new welfare components and the different other elements will change the expected pension at retirement, which can be understood as an income effect. Retirees receiving a PASIS or a self-financed pension lower than the PMG will get a higher pension under the post reform structure. This group of workers faces a negative income effect which discourage participation in the formal labour market. On the other hand, the reform changes the pension accruing rate for any extra worked year. Workers receiving before the reform a self-financed pension (lower than the PMG) will get less extra pension for any extra saved pension wealth as the new subsidy introduced by the reform is decreasing in the pension wealth. This new accrual rate can be understood as a substitution effect generated by the reform. In estimating the effect of the pension reform, I will need to compute expected pension wealth

at time t for each individual upon retirement and the expected accrual rate at retirement of working the current year t, i.e. the pension benefits accruing due to work in this period. In doing so, I will need to estimate the future patterns of contributions to the pension systems and wage profiles, fertility choices, divorce probability and any relevant variable for the new elements of the reform.

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. 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 model can be written as

Outcomes of interest

$$Y_{it} = 1[Y_{it}^* > 0] \tag{5}$$

$$Y_{it}^* = \gamma X_{it} + \beta E_t PW_{iR} + \delta E_t AR_{iR} + \tau_t + \alpha_i + \epsilon_{it} \tag{6}$$

where Y_{it} is the discrete labour supply taking the value of 1 if individual i is working in the formal sector[33] at year t and 0 otherwise, X_{it} is a vector of controls including usual socioeconomic and demographic variables, $\mathrm{E}_t\mathrm{PW}_{iR}$

[33]As I explained before, I define formality according to participation in the pension system. I 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. As self-employed contribute voluntary in the pension system, there is an important fraction of them considered as informal workers.

is the expected (at time t) final 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. 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 formal labour market participation in t. The methodological problems are reflected into the fact that final pension wealth PW and the accrual rate AR 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 (6) will be inconsistent. To overcome this problem, I 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, I will use a version of the "difference in differences" approach, whose key assumption is 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 me to define groups for whom the change in the expected self-financed pension wealth at retirement or the expected pension due to the reform differs. 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 a retiree might receive. Before the reform, workers who did not have enough pension wealth to self-finance a pension above the

PMG, but satisfy the 20 years contributory requirements, 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 final 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 me to avoid to deal with the pension modality choice that workers must do at retirement. I will use the interaction of group dummies with time dummies as instruments for PW variation in equation (6). In this manner I will take care of unobserved heterogeneity and thus will be able to identify the causal effect of the pension reform on labour market participation (and other outcomes).

Thus, one crucial aspect of this methodology is the computation of E_tPW_{iR} and E_tAR_{iR} at each period t. As I have said before, pension wealth depends mainly on the life-cycle wage profile, labour 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.

I propose the following estimation strategy. First I will construct expected final pension wealth and accrual rates, based on the observable history of the individual and on forecasts of their future labour 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 I propose to regress these measures on interactions of cohort, gender and time dummies and use the predicted residuals as a new regressor

in equation (6).[34] 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 labour 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, as the one showed in Section 3, should be used. Here I 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 I 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 for the different groups. The model is discrete and hence I 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.

In order to compute the expected final pension wealth and the accrual rate I predicted future contributions in the pension system using the model described in the next subsection. Once expected pension wealth at retirement is computed, the welfare tier before and after the reform is introduced using the ITF indicator described in the Section 1.5.

[34] I report the results obtained using the standard IV approach as well, i.e using forecasted values for the endogenous variables in the main equation.

2.2 Profiles.

2.2.1 Earnings and contributions profiles.

The elements introduced by the reform create different incentives affecting not only the current individual's labour market decisions but also their complete life-cycle profile of choices. I observe self-reported wages and formal labour market participation from year 2002 to 2009. Using them and other EPS survey information, I estimate equations for labour market participation, sector choice (formal/informal) and wages. These enable me to forecast for each individual the earnings in future periods in which I 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 between the formal $F_{it} = 1$ and the informal labour market sector $F_{it} = 0$, receiving after-tax wages $w_{it}^{F=1}$ and $w_{it}^{F=0}$, respectively. I estimate the following four-equation system by maximum likelihood

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

$$F_{it} = 1[F_{it}^{*} = \gamma_4 Z_{it} + \gamma_5 Q_{it} + \alpha_1 \eta_i + \epsilon_{it} > 0]$$

$$ln(w_{it}^{F=1}) = \gamma_6 Q_{it} + \alpha_2 \eta_i + \nu_{it}^{F=1}$$

$$ln(w_{it}^{F=0}) = \gamma_7 Q_{it} + \alpha_3 \eta_i + \upsilon_{it}^{F=0}$$

Where ξ_{it} and ϵ_{it} are distributed $N(0,1)$, ν_{it} and υ_{it} are shocks distributed according to a bivariate normal distribution $N(\mu, \Sigma)$ and η_i is a common unobservable heterogeneity distributed according to $N(\mu_\eta, \sigma_\eta^2)$. Including η as an outcome of the estimation process allows me to control for different preferences across the population. The set of regressors contain the usual socio-economic and demographic variables. Where Q_{it} is a vector including age, gender, educational dummies, cohort dummies and year dummies; Z_{it} includes the complete set of variables in Q_{it} and the marital status and the number of children by age, finally X_{it} incorporates the all previous variables and the interaction between the number of children and gender. Employees choose to work in the formal sector according to 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 is valued for certain types of workers. I estimate the system by maximum likelihood[35] using just two points on the domain of η, which are estimated jointly with their associated probabilities (Laird [1978], Lindsay

[35]The log likelihood function could be written as

$$L(\gamma,\alpha,\eta,X,Z,Q) = \sum_i ln \int_\eta \prod_t [\{[\phi(\frac{log(w_{it}^{F=1}) - \gamma_6 Q_{it} - \alpha_2\eta_i}{\sigma_\nu})\Phi(\gamma_4 Z_{it}+\gamma_5 Q_{it}+\alpha_1\eta_i)]^F \times$$

$$\times[\phi(\frac{log(w_{it}^{F=0}) - \gamma_7 Q_{it} - \alpha_3\eta_i}{\sigma_\upsilon})\Phi(-\gamma_4 Z_{it}-\gamma_5 Q_{it}-\alpha_1\eta_i)]^{1-F}\Phi(\gamma_1 X_{it}+\gamma_2 Z_{it}+\gamma_3 Q_{it}+\eta_i)^{H)}\}\times$$

$$\times[\Phi(-\gamma_1 X_{it} - \gamma_2 Z_{it} - \gamma_3 Q_{it} - \eta_i)]^{1-H}]dF(\eta)$$

[1983] and Heckman and Singer [1984]). Results are used for forecasting individual wages on the future periods, allowing me to compute the expected accumulated resources at retirement.

The equation system estimations are reported in Table 3 and 4, as shown below. The results for the formal and informal wage profiles, shown 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 the employee is, the higher the wages are. Column 3 shows the estimated parameters for the participation in the formal labour market. The probability to participate in the formal sector is highly explained by educational level; having a degree is one of the main variables explaining formality. The results for participation in the labour market are displayed in the last column. As I mentioned before, women participate less in the labour market than men do. Moreover, the gender difference is even greater when I consider married women and women with children.[36]

[36]I included interactive variables between the number of children and sex, which are not shown in the table as a result of edition.

Table 3: Earning Profiles Estimation

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

Std. errors in parentheses. Dummies year and cohort are included in the estimations.
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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.[37] The higher the value for the individual unobservable heterogeneity, the higher the probability to participate in the formal labour market sector. The results could be interpreted as the existence of two groups within

[37]This is similar to the assumption that η is distributed discretely.

the population. The first group, around 30% of the population ($\phi = 0.315$), has lower preferences for the formal labour 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_{gt} and υ_{gt}, are estimated jointly, $\sigma^{F=1}$ and $\sigma^{F=0}$, with the system. Both shocks have different volatility, as the results indicate.

Table 4: Earning Common Heterogeneity Estimation

Modelling Heterogeneity		
Variables	Coefficients	Std. dev.
Σ		
$\sigma^{F=1}$	0.122***	0.00353
$\sigma^{F=0}$	0.153***	0.00617
ρ	0.092***	0.00234
Heterogeneity		
η_1	−3.309***	0.16400
η_2	−2.062***	0.16200
ϕ	0.315***	0.00447
Coefficients equations		
α_1	2.903***	0.0492
α_2	5.303***	0.0858
α_3	0.129***	0.0230
*** p< 0.01	** p< 0.05	* p< 0.1

The four-system equation estimations control for selection and allow me to forecast those non-observed individuals' period-sector data. Figures 2 and 3 show the predicted average wages and formal participation rates by gender and different cohorts. I can observe the usual bump-shaped life cycle wage and labour market participation profile. The left-side graph of Figure 2 confirms the low female labour market participation highly debated in Chile.

Figure 2: Female labour market profiles

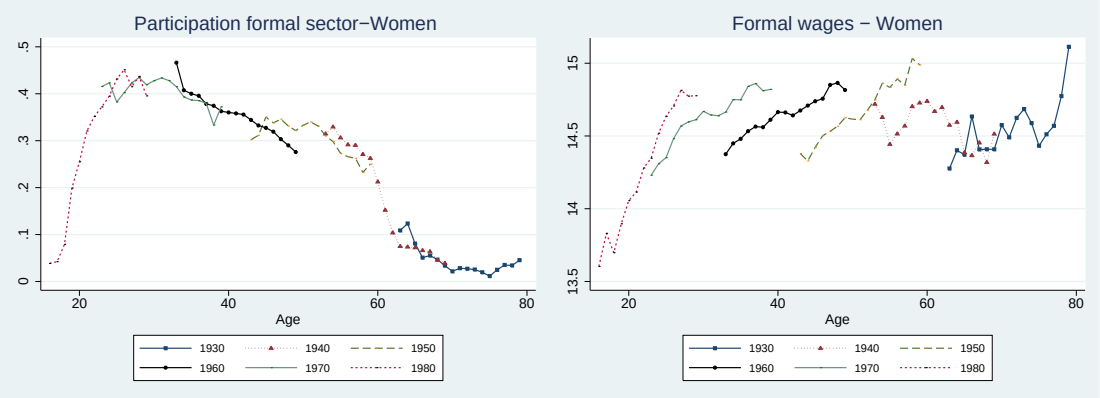
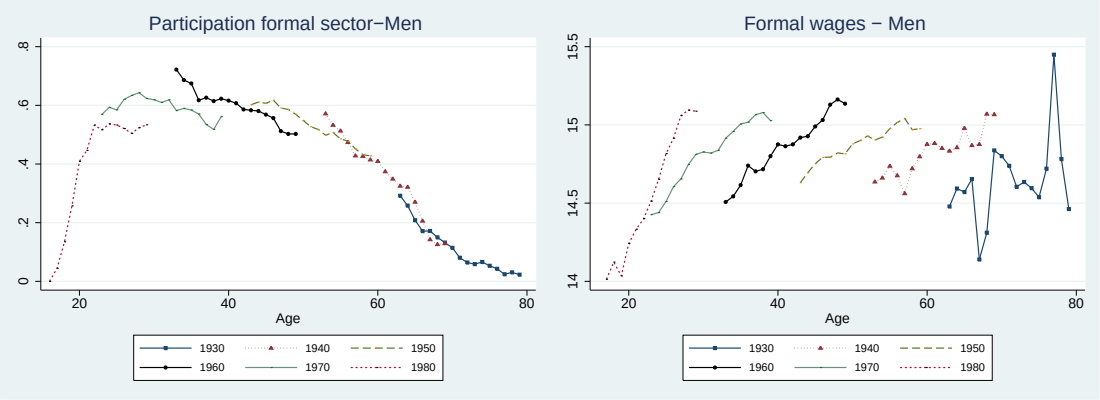


Figure 3: Male labour market profiles



2.2.2 Child Subsidy.

As the reformed system includes a subsidy for every mother, I model how many children a woman will have during her lifetime. I 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.[38]

[38] I assume that individuals expect the same number of children following the reform. Even though it could be argued that the reform will change the fertility choices I do not model the choice of having children.

$$P(\Delta C_{gt} = 1 | C_{gt-1}, age_{gt}, M_{gt}, E_g) = \Phi(X_{gt}\beta)$$

I estimate the equation above by maximum likelihood assuming random effects. The results are shown in the next Table. As 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.

Table 5: Fertility Profiles Estimation

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)**
Trend	-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%

Using these estimations I forecasted for each individual the probability

to have a child conditional on the set of used regressors. Figure 4 shows the average forecasted probability for each cohort of having a child at each age.

Figure 4: Predicted Probability to Have a Child

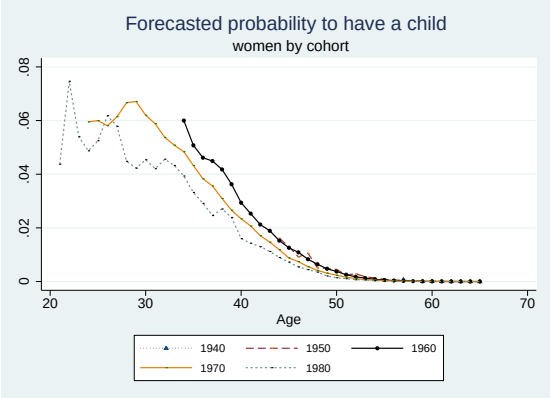
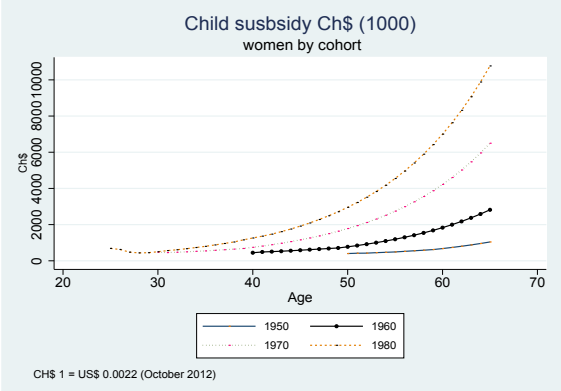


Figure 5: Child Subsidy Simulations



With these results on hand, I then impute to each individual-period a child if a randomly generated number falls within the prediction of the above equation. As I now have the complete fertility profile for each worker, I am able to compute the subsidy that every women will receive at retirement for each born child. The bottom Figure 5 shows the average subsidy for each cohort. As I explained in Section 1.3, the subsidy for each child is

equal to 1.8 times the minimum wage existing at the time of birth of the child.[39] Subsidies earn returns since the date of birth of the child until the date of retirement or from July 2009 until retirement in cases in which 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 1960s will be CLP$ 3,076,090 (US$ 6,767), which represents around 9% of the total expected (at year 2010) accumulated resources at retirement.[40]

2.2.3 Compensation upon divorce.

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

I observe the individual's marriage date and the marital status in the three last waves of the EPS. With this information I 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 socioeconomic and demographic variables, which include age, sex, education E, number of children C, years of marriage YM and dummy variables controlling for cohort effects Dc. The hazard rate function,

[39] In 2009, it was equivalent to CLP$ 286,200 (US$ 630). I assumed an annual rate of growth of 3%.

[40] Including all the elements introduced by the reform detailed previously.

denoted by $h(j)$, or the instantaneous failure rate at time t could be written as

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

Table 6 shows the results for the hazard ratios from a proportional Cox model estimation.

Table 6: Divorce Probability Estimations

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%

The probability of divorce, conditional on being married, decreases with age but increases with the number of years of marriage. The proportion of divorced individuals varies positively with 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 primary school.

In order to be able to forecast the unconditional probability of divorce that an individual will face in each future period, I need to estimate the probability to get married. The probability to get married is estimated using a proportional hazard model in the same way that I did with the probability of divorce. Table 7 shows the results about the marriage choices estimations.

Table 7: Marriage Probability Estimations

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%

The last two waves of the EPS contain information about the partners' contribution patterns. Specifically, the surveys include two questions which allow me to figure out which individual within the couple could be considered as the worse-off member upon divorce. Using the information provided by the two following questions in the EPS, I 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. I basically recorded the

answers creating an indicator between 0 and 1 in the following manner:

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) Did 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 of the time=0.5.

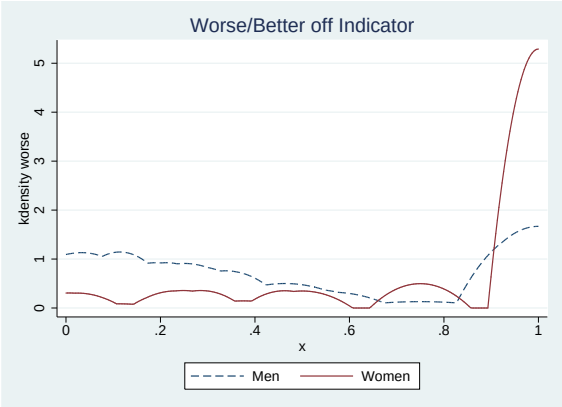
   (d) Under half of the time=0.25.

   (e) Occasionally contributed=0.

With the product of these two new recorded variables, for each at least once married interviewed, I created the worse/better indicator. Its estimated kernel density is shown by gender in the Figure 6. 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 I imputed the indicator using age, education and gender groups. Finally, combining this indicator with the individual's frequency of contributions I imputed an individual as the worse-off member (the better-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 0.2 (above 0.8).

Figure 6: Worse/Better off Indicator

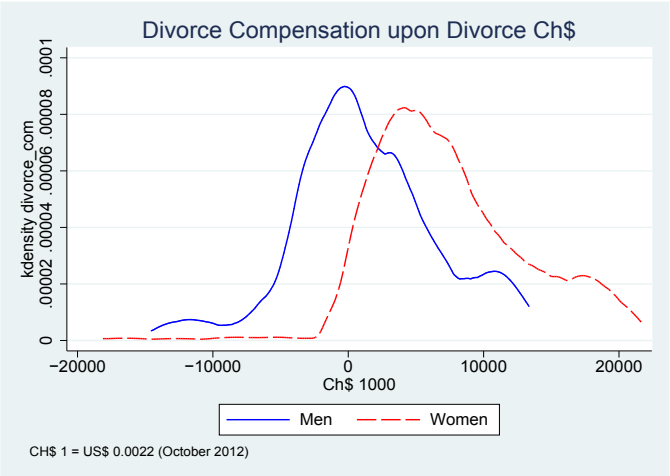


Combining this information with the unconditionally forecasted probability of divorce, the affiliates' accumulated pension wealth at each period and assuming a compensation fraction equal to 30% of the partner pension wealth, I then imputed for each affiliate an expected compensation in the case of divorce. In the same way that I did with the child subsidy, I am assuming here that the reform does not change the expected probability of divorce. Individuals compute their expectations about the probability of being married without taking into account the incentives introduced by the reform. This simplifies enormously the computations and avoids me having

to deal with the potential effects of the reform on marital status.

Figure 7 displays the simulated compensation upon divorce by sex.

Figure 7: Divorce Compensation Simulation

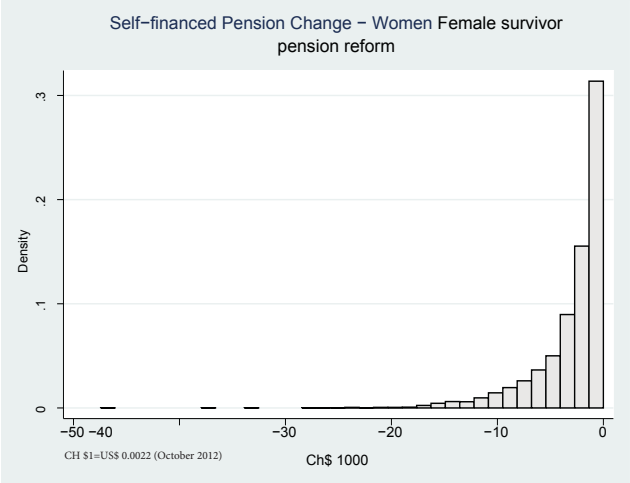


2.2.4 Survivor pension.

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 choose 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, because after the reform the cost for the insurance companies has risen, as they should possibly pay a survivor pension. On the other hand, as I saw in Section 1.6, phased withdrawal computation considers the partner's survivor probability

and then it will change when this new mechanism is introduced. To assess the extent of this new element and its impact on the final pensions, I simulate the female pensions considering both scenarios, financing a survivor pension and not.[41] Figure 8 shows how the frequency of the monthly female self-financed pension moved slightly to the left when this new element is taken into account.

Figure 8: Survivor Pension Effect



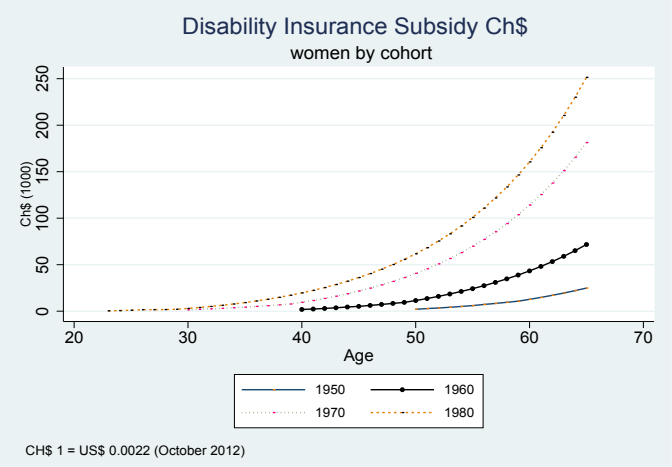
2.2.5 Disability Insurance.

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 insurance. An auction mechanism was incorporated with the reform, in which all FPAs must bid a gender-dependent premium rate. The difference between the male and female premium rate is transferred each period into the women's individual accounts earning returns upon retirement.

[41] Given that I am forecasting marital status, as I previously explained in Section 2.2.3, I do not observe the partner's age for those individuals with imputed marital status. I am assuming that men are two years older than women.

For future periods, I am assuming for every women the average observed premium rate difference since 2008 equal to 0.002 (Reyes [2009]). Figure 9 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.

Figure 9: Disability Insurance Subsidy Simulations



The model captures all elements introduced by the reform through the final pension wealth. The most important components are the two new welfare pensions introduced in the first tier. Both of them constitute around 87% of the additional total final pension wealth due to the reform. On the other hand, the child subsidy, the divorce compensation, the survivor new pension mechanism and the disability insurance premium represent 9%, 3%, 0.3%, and 0.7% of the total additional final pension wealth, respectively. The model incorporates aggregate demographic changes in the economy through the differences in the estimated wages by cohort, the forecasted divorce and

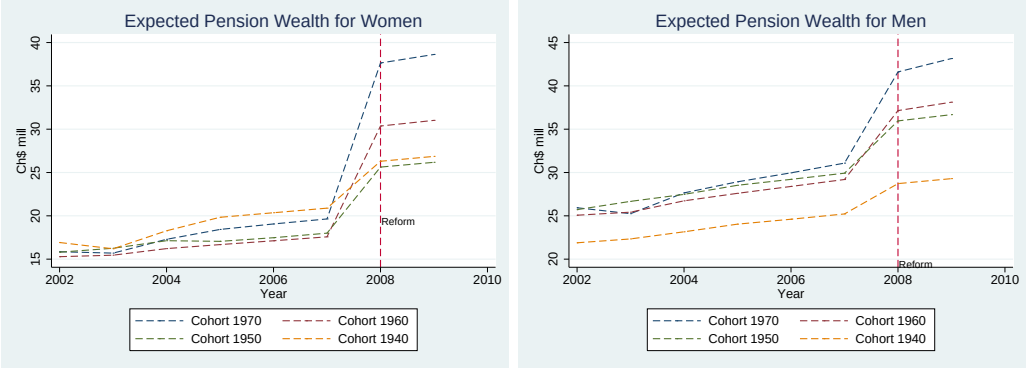
marital patterns through the life cycle and the modeled fertility choices. Market labour regulations are captured by the pension system main frame.[42]

2.3 Pension wealth and accrual rate.

Finally, after assessing the value of all subsidies and incorporating all mechanisms introduced by the reform and listed in Section 1.3, I computed both the expected accumulated pension wealth and accrual rate at retirement for periods $t = \{2002, .., 2009\}$. I 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 obtained from the estimated system explained in Section 2.2.1. I finish incorporating the simulated child subsidy, compensation upon divorce, survivor pension reform and the disability insurance compensation. The next two figures show 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 women as specific targets.

[42]Clearly, there are some components of the labour market which are not considered, such as the unemployment insurance and the health insurance system. They are obvious extensions of this model.

Figure 10: Expected Pension Wealth Simulations



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.[43] As I 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 to the age. Since 2004 onwards only a 30% of the workers have chosen explicitly their funds[44], we can expect that the observed decline of the pension funds' value[45] during the crisis had been differently across cohorts, compensating the increment due to the reform.

On the other hand, the accrual rate will be different before and after the reform depending of the final self-financed pension. The next figures show the expected (at year t) accrual rate at retirement of working the current year

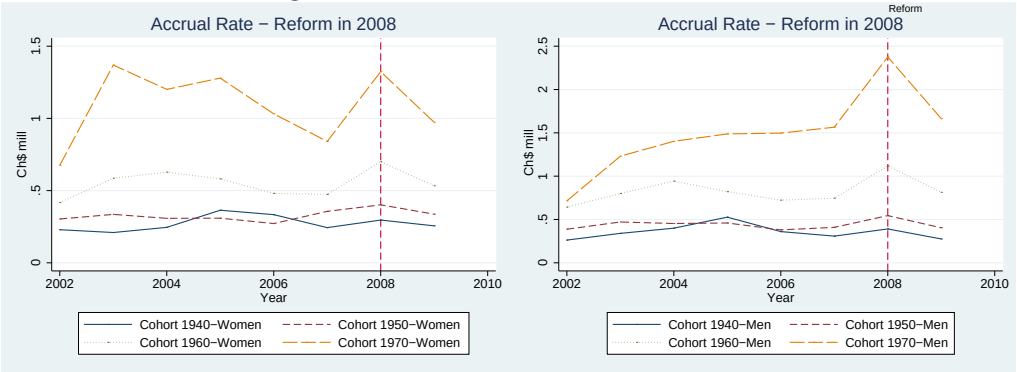
[43]See Hurd and Rohwedder [2010].

[44]Berstein et al. [2011].

[45]The pension system's funds lost in average around 15% of their value. Centro de Estadisticas de la Superintendencia de Pensiones. Rentabilidad Real de los Fondos de Pensiones 2008. Superintendencia de Pensiones, Chile. See http://www.safp.cl/safpstats/stats/ .

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.

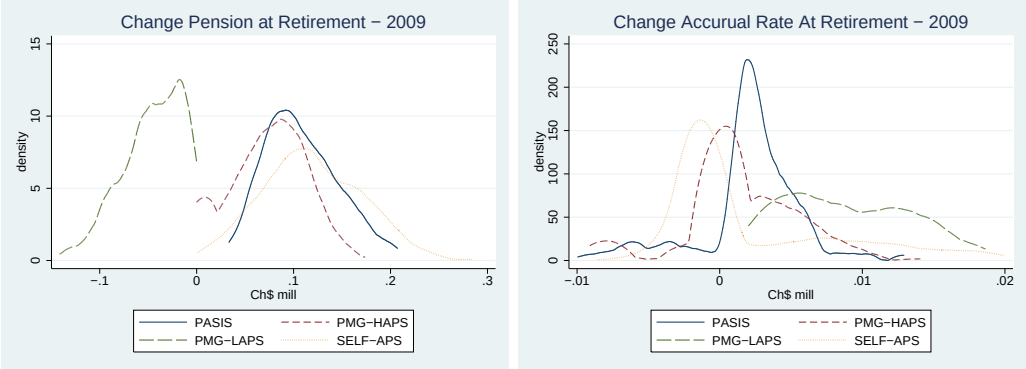
Figure 11: Accrual Rate Simulations



Any variation in either the pension wealth or the accrual rate could explain the changes in formal labour market participation. Conditional on the accrual rate, a rise in the expected pension wealth at retirement reduces 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 labour market sector increasing the probability of being formal. I 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 ex-

tra year will be zero.[46] After the reform, these workers started to receive the PBS plus the APS. Then, for any additional worked year, and consequently for any extra Chilean peso accumulated as pension wealth, workers will receive at retirement a higher pension which means a positive accrual rate. 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 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.

Figure 12: Pension and Accrual Rate Changes



The expected (in 2009) accrual rate has changed in average CLP$ -87,169

[46]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 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.

(US$ 191) and CLP$ -51,669 (US$ 114) after the reform for women and men, respectively. The expected (in 2009) pension wealth increased in CLP$ 13,900,000 (US$ 3,058) and CLP$ 7,576,562 (US$ 16,668) after the reform for women and men, respectively.[47] Finally, 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 and finally on the marginal effect of the probability to contribute due to these changes. Next section deals with this last point.

2.4 Results.

This section reports the two stages estimation for the main equation (6). As I extensively discussed in Subsection 2.1, I estimated a discrete model for the probability to work in the formal sector using a control function approach for the expected final pension wealth variable at retirement. I used as instruments the interaction between time dummies and group dummies, where the groups are cohorts and gender. According to 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.[48] We can see 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 I proceeded to estimate the second stage. In the next table I show the results for women[49]

[47]The average pension wealth and accrual rate changes by age groups and gender are reported in Section A.5.7 in the Appendix A.

[48]See the Appendix A, Section A.1, for the first stage results.

[49]The results for men are in the Appendix A, Section A.2.

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. 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 I control for possible endogeneity using both the IV and CF approaches, I obtain a negative income and a positive substitution effect. Both effects increase with the age, supporting the idea that the marginal effect of the reform is larger for those workers near retirement.

Table 8: Female Formal Labour Market Participation

Dicrete Choice Model Estimations - Pr. to Contribute=1			
Women			
Variables	**NO IV**	**IV**	**CF**
Age	0.0428	0.2019***	0.0529***
	[0.0283]	[0.0437]	[0.0137]
Age2	-0.0003	-0.0024***	-0.0006***
	[0.0003]	[0.0005]	[0.0002]
Primary (1=Yes)	0.7271***	1.1774***	0.5038***
	[0.1180]	[0.1905]	[0.0619]
Secondary(1=Yes)	1.1847***	2.0768***	0.9558***
	[0.1266]	[0.3082]	[0.1164]
Degree(1=Yes)	1.5787***	3.2153***	1.4974***
	[0.1299]	[0.5149]	[0.2141]
Married	-0.4271***	-0.4014***	-0.3575***
	[0.0491]	[0.0516]	[0.0181]
Number Children 0-3	-0.3426***	-0.3713***	-0.2304***
	[0.0378]	[0.0391]	[0.0213]
Number Children 4-5	-0.1843***	-0.2030***	-0.1208***
	[0.0380]	[0.0386]	[0.0249]
Pension Wealth	0.0388***	-0.0281*	-0.0281***
	[0.0059]	[0.0166]	[0.0079]
Pension Wealth*Age	-0.0004**	-0.0005	0.0002
	[0.0001]	[0.0003]	[0.0001]
Accrual Rate	0.0488	0.0269	-0.2676***
	[0.0370]	[0.0388]	[0.0275]
Accrual Rate*Age	0.0020*	0.0039***	0.0136***
	[0.0011]	[0.0013]	[0.0009]
Constant	1.1888***	1.3204***	
Observations	26,778	26,778	26,778

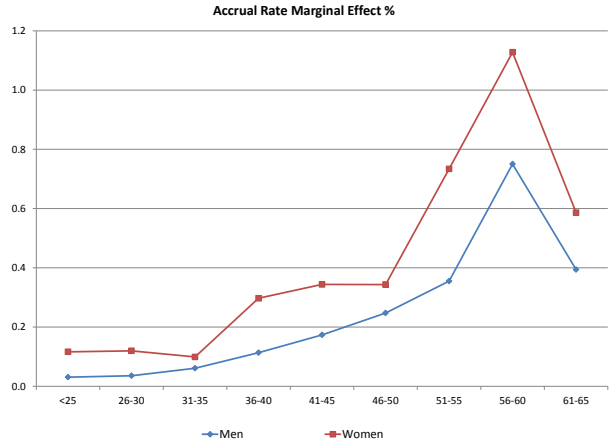
Standard errors in brackets *** p<0.01, ** p<0.05, * p<0.1. Pension Wealth variable is intrumented by groups dummies interacted with year dummies. Pension Wealth and Accrual Rate are both measured in Ch$1000000.

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, I estimate the marginal effects[50] including group age dummies interacted with the pension wealth and the accrual rate, respectively. Using this specification I capture any non-linear effect of the reform by age. The next figure has the marginal effect of a CLP$ 1 mill (US$ 2200) accrual rate change on

[50]Table 24 in the Section A.3 in the Appendix A shows the results for these estimations.

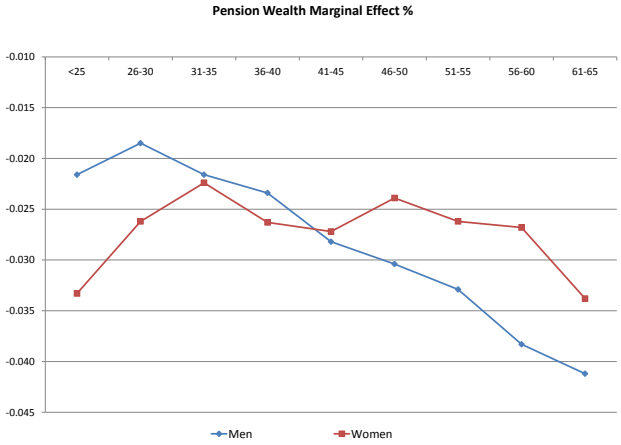
the probability of being formal for men and women by different age groups (columns 3 and 4, in Section A.3 in the Appendix). The graph shows the age increasing and gender dependent positive substitution effect. During the early ages of the life cycle a change of CLP$ 1 mill in the accrual rate rises the probability to contribute to the pension system in less than 0.3%. However, this effect is much larger at the end of the cycle when workers are near to retirement.

Figure 13: Accrual Marginal Effect Estimation



Regarding the pension wealth effect, the next figure shows the marginal effect of a CLP$ 1 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 in the Appendix). I observe a negative and age increasing statistically significant income effect throughout the working life. A rise in CLP$ 1 mill in the pension wealth reduces the probability to participate in the formal market, when the employee is near retirement, in more than 0.03%.

Figure 14: Pension Wealth Marginal Effect Estimation



Using different values for the future probability to work in the formal labour market I recompute both the expected pension wealth and the accrual rate and estimate the equation (6) again for each scenario. The results considering five different probability to contribute scenarios ($Pr = j$) are displayed in the table below[51].

[51]Results for men are in the Section A.4 in the Appendix A.

Table 9: Female Marginal Effects Estimations - Scenarios

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	0.1210***	0.1190***	0.0047	0.0648***	0.0246
	[0.0181]	[0.0191]	[0.0246]	[0.0238]	[0.0243]
Age2	-0.0013***	-0.0013***	-0.0002	-0.0006**	-0.0004*
	[0.0002]	[0.0002]	[0.0003]	[0.0002]	[0.0002]
Married (1=Yes)	-0.3523***	0.4090***	0.4912***	0.2752***	0.3837***
	[0.0176]	[0.0433]	[0.0587]	[0.0554]	[0.0666]
Number Children 0-3	-0.1713***	0.7724***	0.9162***	0.4505***	0.7022***
	[0.0238]	[0.0723]	[0.1090]	[0.1080]	[0.1321]
Number Children 4-5	-0.0818***	1.1726***	1.5209***	0.5043**	1.0688***
	[0.0266]	[0.1407]	[0.2183]	[0.2293]	[0.3034]
Number Children 6-13	-0.0536***	-0.3484***	-0.3821***	-0.3478***	-0.3728***
	[0.0176]	[0.0175]	[0.0191]	[0.0182]	[0.0175]
Number Children 14-18	0.0174	-0.1912***	-0.1918***	-0.2417***	-0.1834***
	[0.0151]	[0.0229]	[0.0238]	[0.0304]	[0.0303]
Pension Wealth* Group Age <25	-0.0412***	-0.0479***	-0.0325***	0.0239*	-0.0167
	[0.0083]	[0.0081]	[0.0109]	[0.0134]	[0.0181]
Pension Wealth* Group Age 26-30	-0.0221***	-0.0242***	-0.0257**	0.0275**	-0.0124
	[0.0072]	[0.0070]	[0.0112]	[0.0132]	[0.0178]
Pension Wealth* Group Age 31-35	-0.0227***	-0.0207***	-0.0234**	0.0279**	-0.0110
	[0.0076]	[0.0073]	[0.0113]	[0.0130]	[0.0177]
Pension Wealth* Group Age 36-40	-0.0253***	-0.0218***	-0.0264**	0.0303**	-0.0137
	[0.0079]	[0.0076]	[0.0114]	[0.0131]	[0.0177]
Pension Wealth* Group Age 41-45	-0.0204**	-0.0197**	-0.0304***	0.0325**	-0.0091
	[0.0084]	[0.0081]	[0.0115]	[0.0130]	[0.0178]
Pension Wealth* Group Age 46-50	-0.0106	-0.0157*	-0.0258**	0.0331**	-0.0055
	[0.0088]	[0.0084]	[0.0117]	[0.0130]	[0.0179]
Pension Wealth* Group Age 51-55	-0.0058	-0.0143	-0.0284**	0.0344***	-0.0020
	[0.0093]	[0.0088]	[0.0121]	[0.0129]	[0.0176]
Pension Wealth* Group Age 56-60	0.0014	-0.0141	-0.0321**	0.0356***	-0.0051
	[0.0098]	[0.0093]	[0.0125]	[0.0131]	[0.0177]
Pension Wealth* Group Age 61-65	-0.0100	-0.0181*	-0.0394***	0.0206	-0.0114
	[0.0110]	[0.0102]	[0.0133]	[0.0144]	[0.0183]
Accrual Rate* Group Age <25	0.6258***	0.6572***	0.0060	0.0066	0.1092***
	[0.0362]	[0.0379]	[0.0271]	[0.0296]	[0.0363]
Accrual Rate* Group Age 26-30	0.4062***	0.3512***	0.0666***	0.0912***	0.1800***
	[0.0220]	[0.0198]	[0.0095]	[0.0248]	[0.0379]
Accrual Rate* Group Age 31-35	0.5239***	0.3366***	0.1287***	0.1400***	0.2672***
	[0.0306]	[0.0219]	[0.0151]	[0.0365]	[0.0566]
Accrual Rate* Group Age 36-40	0.7971***	0.4989***	0.2812***	0.0800**	0.4800***
	[0.0401]	[0.0290]	[0.0289]	[0.0328]	[0.0733]
Accrual Rate* Group Age 41-45	0.7977***	0.4783***	0.4933***	0.1002***	0.2580***
	[0.0520]	[0.0373]	[0.0425]	[0.0304]	[0.0679]
Accrual Rate* Group Age 46-50	0.6833***	0.5396***	0.3534***	0.1560***	0.4999***
	[0.0643]	[0.0488]	[0.0452]	[0.0510]	[0.0705]
Accrual Rate* Group Age 51-55	0.6787***	0.8170***	0.6956***	0.1370***	0.5235***
	[0.0749]	[0.0798]	[0.0714]	[0.0530]	[0.0809]
Accrual Rate* Group Age 56-60	0.6691***	1.3440***	1.5403***	0.2394**	1.2746***
	[0.1061]	[0.1389]	[0.1617]	[0.1021]	[0.1866]
Accrual Rate* Group Age 61-65	0.9201***	0.7747***	1.0900***	-0.1344	0.4328
	[0.2285]	[0.2325]	[0.2319]	[0.5243]	[0.3849]
Residual	0.0724***	0.0721***	0.0693***	-0.0027	0.0346*
	[0.0079]	[0.0077]	[0.0116]	[0.0145]	[0.0188]

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 most of the scenarios assumed. Regarding the accrual rate coefficient, its magnitude turns lower as the probability to contribute to the system increases from 0.1, reversing as a U shaped when the probability to contribute converge to 1. As the reform reduces in average the accrual rate, Section 2.3, there is 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, being no significant for the higher probabilities scenarios. Both effects complement each other reducing in average the probability to contribute in the pension system by 5.2% and 3.4% for women and men[52], respectively.

2.4.1 Pension Wealth Changes.

2.4.1.1 Changes in the accumulated pension wealth before and after the reform. In Figure 15, I show some evidence on the changes in the self-financed pension wealth accumulated in the individual accounts before and after the reform. Any observed change after the reform will be due to the new mechanism and subsidies other than the changes to the first tier. The graphs display the frequency distribution for the self-financed pension wealth for women belonging to the 1940 and 1960 cohorts. Taking into account that older workers, at the moment of the reform, do not have many years to take advantage of the subsidies, such as the return for every born

[52]The final average effect is computed, first, forecasting the individual probability to contribute according to the pre and post reform scenarios, which allows me to compute the individual percentage change in the probability to contribute due to the reform, and then averaging the individual effects.

child or the disability insurance compensation, the change for older cohorts should be smaller than the one for younger cohorts.[53]

Figure 15: Pension Wealth Changes

The average predicted self-financed pension wealth change for employees born in the 60s is CLP$ 1,020,413 (US$ 2,244) which is almost 8 times larger than the change for the ones born in the 40s and represents an average increment of 4% of the PW before reform.

2.4.1.2 Changes in the frequency of pensions resulting from the reform. I have showed that the subsidies introduced by the reform changed the accumulated resources and through it the self-financed pension. Additionally, conditional to a particular self-financed pension wealth, the changes introduced to the first tier of the system modified the final pension distribution. These changes are different for different population groups. For instance, as some elements of the reform are just affecting younger workers, the change in final pension will be probably larger for this group. In the two

[53]Section A.5.3 in the Appendix A has figures with the frequency of the self-financed pension wealth by educational levels.

panels of Figure 16, I plot the frequency distribution of pension amounts, measured in CLP$1,000 (US$ 2,2), before and after the reform, for female[54] 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.[55] This is the first group of employees retiring under the post reform system. The 1960 cohort, composed by employees who will retire around 2025-2035, is the first group 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 monthly female pension change is CLP$ 29,748 (US$ 65) for those workers belonging to 1940 cohort and CLP$ 69,231 (US$ 152) for those belonging to 1960 cohort, representing an increment of 25% and 69% of the final pension before reform, respectively.

The most impressive change, however, is the shift in the distribution. The left tail of both distributions is substantially reduced and the middle of the distribution is increased. In Section 2.4.2 below I show how these shifts are reflected in changes in different measures of inequality.

Figure 16: Female Frequency of Pensions by Cohort

[54]The same graphs for men are in the Appendix A, Section A.5.1
[55]I am just considering those who have not retired in 2009 yet.

As long as the first tier reform affects particularly 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. In the two panels of Figure 17, I graph pension distribution for workers without formal education or incomplete primary school, and for those who got a college degree, respectively.[56] Although the reform shifts the distribution for both groups, it is clearly much more important for the group with lower education, who are much more directly affected by the changes in the first tier. While the graph refers to the 1940 cohort, a similar story holds for other cohorts[57].

Figure 17: Female Frequency of Pensions by Education

2.4.1.3 Changes in the frequency of the gender pension difference.

As some of the subsidies were specifically target to women, we can expect larger shifts for the frequency of female final pensions than for that of men

[56]The frequency of pensions for workers with primary and secondary level of education are in the Appendix A, Section A.5.1.

[57]See the Section A.5.1 in the Appendix A.

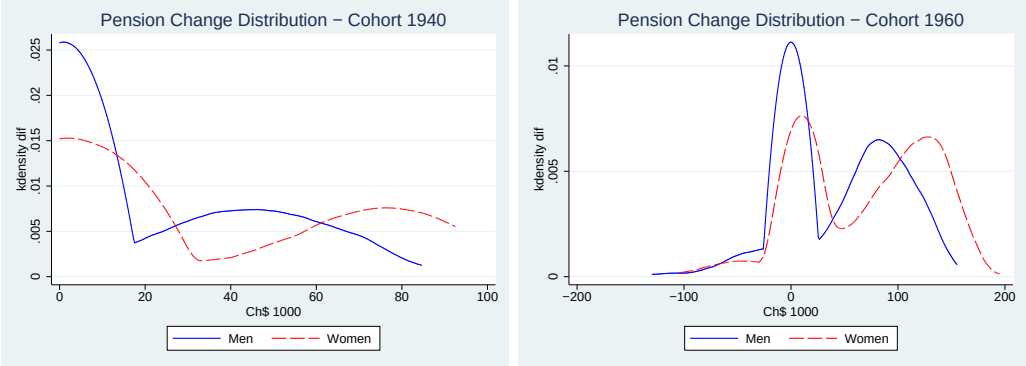
pensions. This hypothesis is strongly supported comparing the two panels of Figure 18, that plot, for the 1940 cohort, the frequency of pensions before and after the reform for men and women. Although the final pensions increase in both cases, the change in the distribution is much larger for female pensions, reducing substantially the gap between them. The gender pension difference for workers belonging to the 1940 cohort is CLP$ 23,254 (US$ 51) and CLP$ 14,073 (US$ 9) before and after the reform, respectively. Graphs for the 1960 cohort are in the Appendix A, Section A.5.2. The gender pension difference for workers belonging to the 1960 cohort is CLP$ 81,120 (US$ 178) and CLP$57,379 (US$ 126) before and after the reform, respectively.

Figure 18: Frequency of Pensions by Cohort

The two panels of Figure 19, show the estimated frequency distribution for the pension changes induced by the reform, considering two different cohorts. In Section A.5.2 of the Appendix A, I report figures with the frequency distribution for pension changes by educational level. The final pension increases importantly for both cohorts. However, the increase is clearly larger for those workers belonging to the 1960 cohort. In both cases the increase in female pensions is larger than that for males, closing gender inequalities. The

average change for the female pension is CLP$ 77,977 (US$ 172), which is 70% larger than the average male change. The average male pension change is CLP$ 15,148 (US$ 11) and CLP$ 35,263 (US$ 78) for those workers belonging to the 1940 and 1960 cohort, respectively.

Figure 19: Pension Change Distribution by Cohort



2.4.2 Inequality and Poverty Changes.

2.4.2.1 Changes in pensions and pension wealth inequality. Having looked at changes in the distribution of pension and pension wealth, I now focus on specific measures of inequality that complement the graphical analysis I have provided so far. In particular, for both final pension and pension wealth, and for both men and women, I report the level of the Gini coefficient, the standard deviation of logs as well as ratios of different quantiles of the distribution. I start, in Tables 10 and 11, with some figures for the distribution of accumulated pension wealth. As I mentioned before, this does not take into account the first tier and the redistributive role that it plays and focuses only on the predicted amount in the individual accounts

upon retirement. In each table, I report two panels, one for women and one for men and, in each panel, figures for different cohorts and for the total.

A simple look at Table 10 and 11 confirms what was already evident from the analysis of the distribution graphs: the changes in the means in Figure 10 hide much more complex changes in the distribution. The general picture is that, even neglecting the effect of Tier 1 and the redistributive role it plays, the reform reduces the amount of inequality in accumulated pension wealth for women. The overall Gini coefficient for women is reduced from 0.53 to 0.49. The standard deviation of logs from 1.21 to 1.04. The reduction in inequality is particularly marked for the youngest cohorts.

For men, instead, there are virtually no changes in inequality in accumulated pension wealth. These results are explained by the fact that the changes in accumulated wealth induced by the reform are mainly driven by the child subsidies, the divorce regulations and the other elements I discussed. It is remarkable that they not only reduce the inequality between men and women but also inequality among women.

The general story that emerges from Table 10 is confirmed in Table 11, where I report the ratios of different percentiles. Once again, only the ratios of women change with the reform. I notice that the largest reductions seem to occur in the left tail of the distribution. For instance, for the whole sample of women, the ratio between the 90th and 50th percentile goes from 1.39 to 1.24, while the ratio between the 50th and 10th percentile goes from 1.73 to 1.41. Once again the largest reductions in inequality occurs for the youngest cohorts.

Table 10: Pension Wealth Inequality Measures

Inequality Measures Final Pension Wealth - Before (BR) and After (AR) Reform	St.deviation BR	St.deviation AR	Gini Coeff. BR	Gini Coeff. AR
Women				
Cohort 1940	1.94	1.72	0.60	0.60
Cohort 1950	1.47	1.28	0.62	0.59
Cohort 1960	1.19	1.01	0.56	0.51
Cohort 1970	1.05	0.85	0.49	0.43
Cohort 1980	0.86	0.76	0.43	0.38
Total	1.21	1.04	0.53	0.49
Men				
Cohort 1940	1.20	1.20	0.53	0.53
Cohort 1950	1.11	1.11	0.50	0.50
Cohort 1960	0.98	0.98	0.46	0.46
Cohort 1970	0.82	0.82	0.40	0.40
Cohort 1980	0.71	0.71	0.36	0.36
Total	0.95	0.95	0.44	0.44

Pension Wealth is the total accumulated saving into the individuals accounts.

Table 11: Pension Wealth Inequality Measures

Inequality Measures Final Pension Wealth - Before (BR) and After (AR) Reform	P90/P10 BR	P90/P10 AR	P90/P50 BR	P90/P50 AR	P75/P25 BR	P75/P25 AR	P50/P10 BR	P50/P10 AR
Women								
Cohort 1940	5.28	4.60	1.90	1.87	2.91	2.78	3.38	2.72
Cohort 1950	3.90	3.38	1.82	1.74	2.12	1.82	2.08	1.64
Cohort 1960	3.17	2.66	1.58	1.42	1.81	1.45	1.59	1.24
Cohort 1970	2.77	2.20	1.21	1.07	1.52	1.18	1.56	1.13
Cohort 1980	2.32	1.91	1.01	0.90	1.18	0.97	1.32	1.01
Total	3.12	2.65	1.39	1.24	1.73	1.44	1.73	1.41
Men								
Cohort 1940	3.12	3.12	1.41	1.41	1.23	1.23	1.71	1.71
Cohort 1950	2.83	2.84	1.24	1.24	1.31	1.31	1.60	1.60
Cohort 1960	2.55	2.55	1.08	1.09	1.26	1.25	1.46	1.46
Cohort 1970	2.09	2.10	0.90	0.90	1.06	1.06	1.20	1.20
Cohort 1980	1.81	1.82	0.80	0.80	0.94	0.94	1.01	1.01
Total	2.38	2.38	1.01	1.01	1.19	1.20	1.37	1.37

Pension Wealth is the total accumulated savings into the individuals accounts.

In Tables 12 and 13, I report the inequality measures and ratio of percentiles for predicted pensions. As mention above, the main reason these tables differ from Tables 10 and 11 is that they reflect the redistributive role

played by the first tier and the social pensions, before and after the reform. First, as to be expected, the inequality measures in Table 12 are considerably lower than those in Table 10. Moreover, the reduction is more pronounced after the reform than before. For instance, if I compare the Gini coefficient for women in Table 10 and Table 12 it goes from 0.53 for pension wealth to 0.49 for pension entitlements before the reform. The same figures after the reform are 0.49 and 0.38: the first tier after the reform implies an 11 point reduction in the Gini coefficient when going from pension wealth to pension. Before the reform the same reduction was only 4 points.

The second thing to notice is that, while in Tables 10 and 11 there are no effects on men, now the more aggressive (and more expensive) first tier implies a reduction in inequality for men as well as women. For instance, the overall Gini for men goes from 0.42 to 0.36, while that for women is reduced from 0.49 to 0.38.

The final element to notice, is that in Table 13, the changes in the left tail of the distribution of pensions are somewhat surprising. In particular, I notice that the ratio between the 50th and 10th percentile distribution of pensions for some cohort increases (rather than decrease) for some cohorts, especially the younger cohort of women. This somewhat surprising result is probably explained by the complexity of the reform and by the fact that the 10th percentile of pension values increases moderately after the reform while the 50th percentile pension value increase greatly, explaining most of the change.

Table 12: Pension Inequality Measures

Inequality Measures Final Pension - Before (BR) and After (AR) Reform	St.deviation BR	St.deviation AR	Gini Coeff. BR	Gini Coeff. AR
Women				
Cohort 1940	1.83	1.50	0.57	0.50
Cohort 1950	1.40	1.18	0.59	0.48
Cohort 1960	1.09	0.91	0.52	0.37
Cohort 1970	0.94	0.78	0.45	0.32
Cohort 1980	0.75	0.76	0.39	0.31
Total	1.11	0.95	0.49	0.38
Men				
Cohort 1940	1.12	1.07	0.51	0.48
Cohort 1950	1.02	0.90	0.48	0.42
Cohort 1960	0.89	0.79	0.44	0.36
Cohort 1970	0.78	0.71	0.39	0.33
Cohort 1980	0.67	0.65	0.34	0.30
Total	0.88	0.80	0.42	0.36

Table 13: Pension Inequality Measures

Inequality Measures Final Pension - Before (BR) and After (AR) Reform	P90/P10 BR	P90/P10 AR	P90/P50 BR	P90/P50 AR	P75/P25 BR	P75/P25 AR	P50/P10 BR	P50/P10 AR
Women								
Cohort 1940	5.15	3.97	1.81	1.24	2.40	1.51	3.34	2.73
Cohort 1950	3.67	3.00	1.55	0.89	1.84	1.43	2.12	2.11
Cohort 1960	2.96	2.31	1.35	0.63	1.55	1.05	1.62	1.67
Cohort 1970	2.47	1.88	1.19	0.52	1.18	0.93	1.29	1.36
Cohort 1980	1.97	1.84	0.99	0.42	0.88	0.99	0.98	1.42
Total	2.87	2.30	1.25	0.70	1.43	1.13	1.62	1.60
Men								
Cohort 1940	2.87	2.69	1.28	1.21	1.16	1.06	1.60	1.49
Cohort 1950	2.51	2.13	1.21	1.02	1.28	0.82	1.30	1.12
Cohort 1960	2.23	1.93	1.03	0.79	1.22	0.72	1.19	1.14
Cohort 1970	1.91	1.76	0.89	0.64	0.99	0.72	1.02	1.12
Cohort 1980	1.70	1.61	0.77	0.55	0.84	0.74	0.93	1.05
Total	2.14	1.92	0.96	0.77	1.13	0.86	1.18	1.15

2.4.2.2 Changes in poverty levels before and after the reform for elderly people, in particular, for elderly women. Between 1990 to

2006 the fraction of the Chilean population below the poverty line decreased gradually from 39% to 14%. This reduction has also been important among the elderly population, changing from 21% to 8%, for those older than 60 years old.[58] One of the objectives of the reform was the reduction of the prevalence of poverty among pensioners. Therefore another interesting aspects of the distribution of pensions before and after the reform I might want to consider is the prevalence of poverty at retirement.

The two panels of Figure 20 and 21 show, for different groups, the cumulative distribution of expected pensions at retirement before and after the reform. Using the poverty line set by the government at CLP$64,000 (US$ 141) in 2009[59], I show the fraction of retirees who, are below the poverty line, assuming that they do not have any other income source. The poverty levels usually reported by the Chilean Government are computed considering per-capita household income, which includes all household earnings, pensions and all different types of governmental transfers and subsidies. In what follows I only look at individual pensions. The results are therefore not directly comparable with the Government poverty statistics. However, the point that I want to make here is to show how the reform changes the left tail of the distribution of pensions. I choose as the cut off point at which I look the level that defines poverty in the absence of other incomes.

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

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

Figure 20: Poverty Level Changes by Cohort

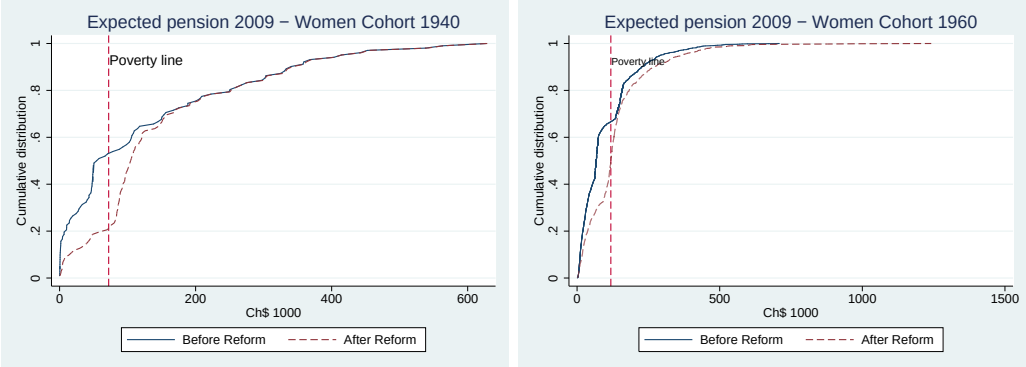
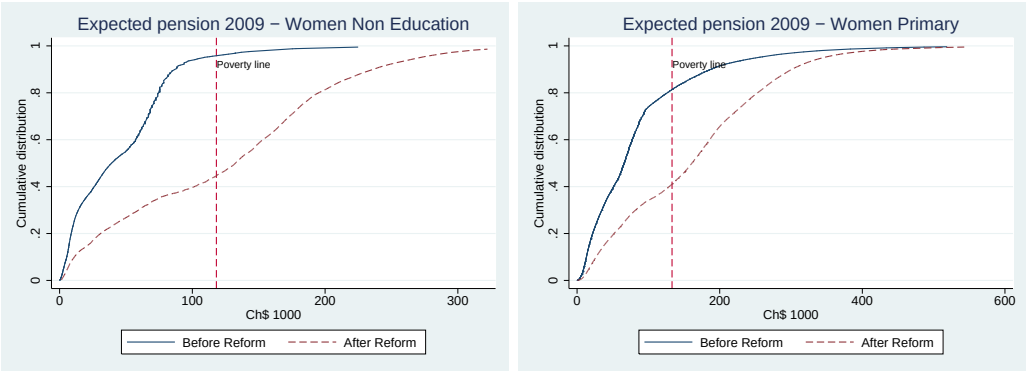


Figure 21: Poverty Level Changes by Education



The reform reduces the fraction of women with a pension below the poverty line by 32% (from 53% to 21%) and 36% (from 56% to 20%) for the 1940 and 1960 cohort, respectively. This effect differs by educational level and is particularly relevant for low education groups. For example, for women without complete primary education, the prevalence of (expected) pensions below the poverty line goes from over 90% to just over 40%.

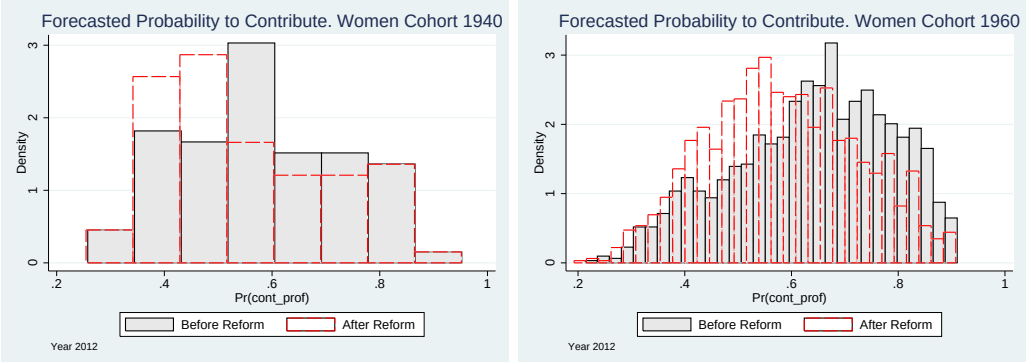
Finally, it is important to note that, by changing the present discounted value of future benefits and how participation into the labour market affects future pension rights, the reform will change current and future labour sup-

ply as well as the participation into the formal labour market. So far, I have focused on the immediate impact of the reform on pension wealth and inequality, however it is expected that the new incentives will change labour market participation. From a theoretical point of view, the reform has an ambiguous effect on participation to the formal labour market. Most individuals will experience both income and substitution effects as a consequence of the reform. The former will typically decrease the propensity to participate to the formal labour market, while the latter can go both ways, depending on whether, for a specific individual, the rate of conversion of participation into future pension benefits (the accrual rate) increases or decreases, that is where in Figure 1 each individual is located. I have found that, empirically, income and substitution effects work in a way consistent with the theory. When aggregating the different impacts, I find that the overall effect on the probability to contribute to pension system is negative as a result of the reform, reducing the participation in the formal labour market by around 4.1% for those workers older than 40 years old. The results differ by gender and age. The reform reduces the probability of being formal by 3.2% and 2.8% for women and men between 56 and 65 years old, respectively. As the reform has reduced the probability to contribute to the pension system we can expect a lower increment in the final pension due to the reform. The next section shows detailed how the probability to contribute to the pension system has been affected by the reform.

2.4.3 Labour Market Participation Changes.

2.4.3.1 Changes in the probability to contribute and changes in the frequency of contributions. In this section I use the 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 I 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[60] to the pension system in 2012 under the pre and post reform system's rule. As I discussed in the Section 2.1, 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 each other reducing the probability of being formal. The probability to contribute in 2012 decreases in average by 3% and 5% for women belonging to 1940 and 1960 cohort, respectively.

Figure 22: Forecasted Probability to Work Formally

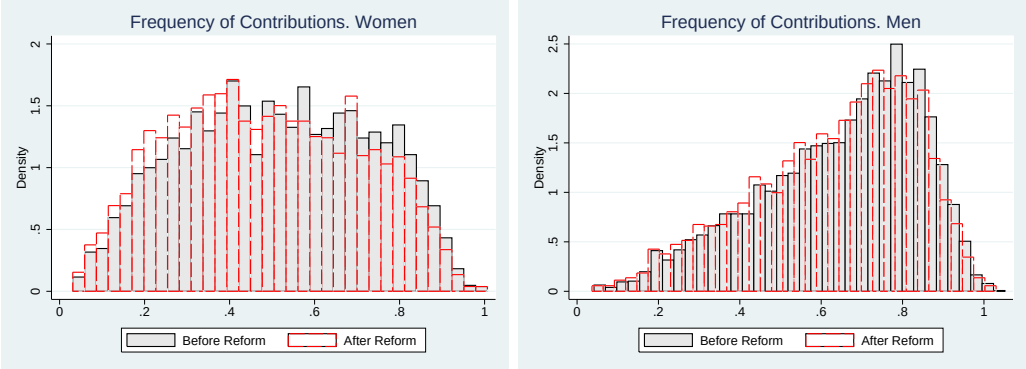


Using these forecasted probabilities I compute how the frequency of con-

[60]The results for cohorts born in 1950 and 1970 are in the Appendix A, Section A.5.5.

tributions, 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. The reform affects negatively the frequency of contributions for both gender, being the negative effect larger for women than for men. The frequency of contributions decreases in average by 2.8% for women and 1.5% for men.

Figure 23: Frequency of Contributions



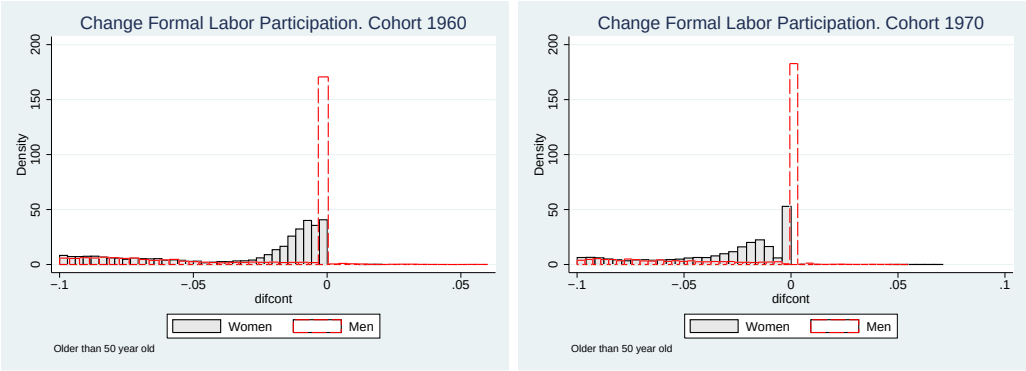
Using the predicted probabilities to contribute I impute to each future individual-period a contributed period if a randomly generated number falls within the predictions. Then, I compute the fraction of individuals, over the economically active people and employees[61], contributing each period under the pre and post reform conditions. Under both measures the reform reduces the coverage of the pension system being the effects larger for the last part of the working life cycle. The fraction of women and men working formally decreases in average by 4.3% and 1.7%, respectively, when the computation

[61]Regarding the participation over the total employees, as I do not observe future labour market participation I proceed to impute it using the estimated system in the Section 2.2.1. This allows me to define those individual-period observations where individuals are working.

is done over the economically active people and 2.1% and 1.1% when it is done over the employees.

2.4.3.2 Changes in male and female formal labour market participation. Many elements of the reform were explicitly designed to improve final female pensions, reducing in this way the observed gender pension gap. The child subsidy is an attempt to recognize the non contributed periods due to childbearing, the disability 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 labour 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 formal labour market participation by gender.

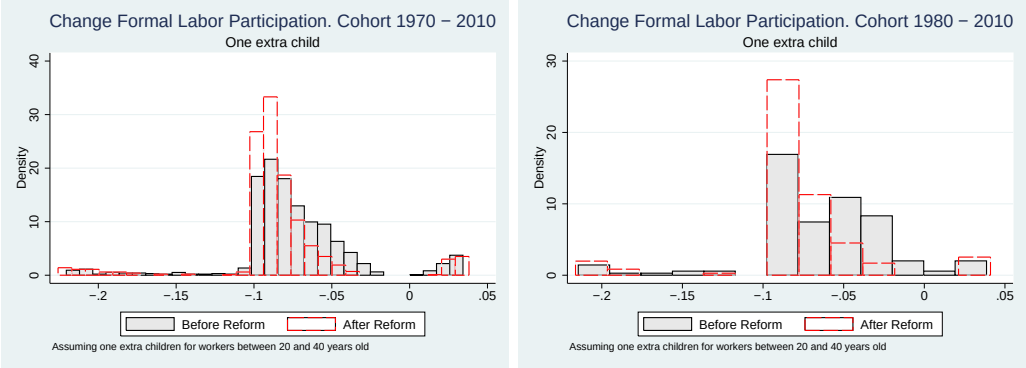
Figure 24: Formality Changes



As was expected, the shift for the female pension frequency is larger than the one observed for men. Those men self-financing a pension larger than the PMAS will not be affected by the first tier reform. Therefore, the incentives to participate in the formal labour market will not change as the expected final pension wealth and the accrual rate remain the same.

2.4.3.3 Effects of having a child on the labour market participation before and after the reform. In this subsection I 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. I am 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, through the new child subsidy, an income effect at retirement. Therefore, I 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 0.03% for women younger than 40 years old.

Figure 25: Fertility Effects on Formal labour Market Participation



2.5 Final Considerations.

In this section I have measured the direct effects of the reform on the final pension distribution and estimate the effects of the reform on formal labour market participation. The reform's eligibility conditions, such as being poor, young or female, has allowed me to define groups for whom the change in the currently expected pension wealth at retirement due to the reform differs. I therefore exploited the differential effects of the reform on individuals belonging to several year-of-birth cohorts and different groups to gain identification. In doing so, I computed 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, I 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 obtained results in this section allows to extent potential and par-

tial labour market effects for either future new modifications to the pension system or future improvements to the different mechanisms and subsidies already implemented. In this sense, the marginal income and substitution effect computed in this section becomes a useful tool to guide ex-ante evaluations for any future system reform. The 2008 reform aimed not only to guarantee a minimum level of consumption upon retirement, prevent old-age poverty and reduce gender inequalities but also to encourage participation in the formal labour market. As I have seen through the section, the reform has increased importantly the pension wealth, specially for women, accomplishing the first set of goals. However, at the same time it has reduced the incentives to participate in the formal labour market. The main reason argued here has been a trade-off, in terms of pension wealth improvements and formal labour market participation, that the new subsidies and welfare pensions have raised. The larger pensions due to the reform have slightly reduced the incentives to work formally, through a direct negative income effect and an indirect substitution effect explained by the changes in the accrual rate. This trade-off rises the point about the optimal subsidies and welfare pensions.

The main results of this section can be summarized in the following way. Firstly, the changes in the final pension wealth at retirement and the accrual rate have reduced formal labour market participation. The probability to contribute to pension system has decreased as a result of the reform, reducing the participation in the formal labour market by around 4.1% for those workers older than 40 years old. The results differ by gender and age. The reform reduces the probability of being formal by 3.2% and 2.8% for women

and men between 56 and 65 years old, respectively. Secondly, 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 by 0.6% and 15%, respectively. Even though the final pension changes have been positive for both gender, the female pension improvement has been 56% higher than the rise for men reducing importantly the gender inequalities.

This section is not without limitations and the results should be taken with some caution. Predicting future earnings and family histories is intrinsically difficult, although the use of individual histories, gained from administrative data makes me confident of the relevance of my predictions. Probably the main limitation is that I do not incorporate in my predictions of earnings and contributory behavior any changes that might be caused by the reform. In this sense, this section should be interpreted as a first order approximation of future pensions and labour supply changes induced by the reform, as it does not incorporate behavioral changes. In order to capture all behavioral changes due to the reform a fully structural model should be used. Next section deals with this point.

3 A Structural Household Life Cycle Model of Consumption Labour Supply and Pension Saving

In order to estimate the effects of the new pension incentives on formal labour market participation, considering all behavioral effects due to the reform, this section solves a dynamic partial equilibrium structural life cycle model of consumption, labour supply and pension savings (Berkovec and Stern [1991], Rust and Phelan [1997], Gustman and Steinmeier [2004], Klaauw and Wolpin [2008], Joubert and Todd [2011], French and Jones [2011]). A two-earners' household optimally choose each period individuals' consumption and labour supply. Individuals can work either in the formal or in the informal sector or not work at all.

The main contributions of this section are twofold. Firstly, it solves and estimates a dynamic consumption, labour supply and pension savings accumulation life cycle structural model. It complements the existing literature by incorporating the choice of two sectors in the labour market, the formal and informal labour sectors (Klaauw and Wolpin [2008], Joubert and Todd [2011]) and by allowing for intrahousehold bargaining power (Voena [2011]). Households choose individuals' sector labour supply and consumption in an environment with uncertainty given by sectoral wage shocks, future marital status and future fertility choices. The model enables workers to borrow against non-pension savings, considering current and future intrahousehold allocation in consumption and labour supply and future possibilities to di-

vorce, marriage and the birth of more children. Gender bargaining power within the household determines the intrahousehold sharing rule. In particular, the larger the male bargaining power, the lower the female welfare improvement is due to a pension wealth increase. As total pension income is consumed by each household's member according to the sharing rule, any female pension improvement increases her husband's resources. Therefore, gender welfare changes due to the reform depend on gender bargaining power. I estimate structurally the gender bargaining power change exploiting the fact that the reform exogenously changes the original income female situation within the household.

Secondly, I compare the results with the evaluation made in Section 2, which, as I described before, estimates the impact of the reform using a control function approach. This methodology exploits the fact that the reform differently affects different groups of the population, such as individuals belonging to different age cohorts and gender. In the past section I compute the mechanical distributional effects of the reform, considering both the first-tier reform and the various contributory tier elements introduced. Importantly, I show that the reform has reduced the inequalities observed in the system, closing the historical gender gap, increased average final pensions and reduced the probability of contributing to the system. This methodology partially captures some behavioral effects, estimating how the current labour market choices change due to the reform. However, it does not incorporate the effect of those new current labour market choices, and eventually future labour choices, on future pensions at retirement. I does not consider how the reform could affect the complete lifetime path of labour market choices and

consequently the long-term impact of the reform. Without a fully structural model that includes forward-looking behavior, it is not possible to control for this endogenous process between pensions at retirement and the complete life cycle path of labour choices. Comparing the reduced-form empirical strategy with the structural model enables one to understand and compute the bias obtained when forward-looking behavior is not considered and to highlight the relevance of considering fully structural models to evaluate major public policies (Todd and Wolpin [2006], Attanasio et al. [2012b]). The estimates from the reduced-form methodology are somewhat different; for workers over 60, the reform is estimated to have a 0.2% larger effect on formal labour market participation, whereas for younger workers between 41 and 45 years old, the estimate is 3% smaller. The main reason to explain this it is that the trade-off, in terms of pension wealth improvements and formal labour market participation, that the new subsidies and welfare pensions have raised is not considered by the reduced-form strategy. The larger pensions due to the reform have reduced the incentives to work formally through a direct negative income effect, which is not offset by the positive substitution effect given by the changes in the accrual rate. This trade-off raises, as I mentioned before, a point about the optimal subsidies and welfare pensions in designing the optimal incentives to increase participation in the pension systems, reducing fiscal burden, and guaranteeing minimum levels of consumption for retirees.

Joubert and Todd [2011] estimate a structural model to evaluate the impact of the 2008 Chilean pension reform. Unlike this section they model the household's consumption choices splitting non-saved income between both household's members evenly. They assume symmetric bargaining power

within the household and do not allow for borrowing against non-pension income. On the other hand, they assume that the worse-off member upon divorce gets the maximum of either their own pension or one-half of the pooled household pension savings and they do not include the changes in the survivor benefit introduced by the reform. Their results go in the same direction than the previous studies and mine, formal labour market participation approximately decreases by 10% and 19% for women and men between 60 and 65 years old, respectively.

The main results of this section are as follows: First, 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 on average see increases of 0.3% and 22%, respectively. Secondly, the new incentives introduced by the reform have reduced formal labour market participation. The probability to contribute to the pension system has decreased as a result of the reform, reducing participation in the formal labour market by around 4.2% for those workers older than 40 years old. The results are significantly higher for women. The reform reduces the probability of being formal by 2.7% and 2.3% for women and men between 61 and 65 years old, respectively. Thirdly, even though the final pension changes have been positive for both gender, the female pension improvement has been 32% higher than the rise for men reducing importantly the gender inequalities. The first tier after the reform implies a 17-point reduction in the Gini coefficient. Before the reform, the same reduction was only 6 points.

The estimated bargaining power coefficient using pre-reform data is equal to 0.64, meaning that the male bargaining power within the household is almost double that of females. When estimations are done using post-reform data, the estimated bargaining power decreases to 0.61, showing that the reform has increased female bargaining power by about 0.3 points.

3.1 Model

I solve a partial equilibrium life-cycle model with two-earners' households choosing optimally consumption, labour supply, and pension savings for each period.[62] I model both single households composed of either a man or a woman and two-earners' households, which are composed of a husband and a wife. Households maximize each period of their lifetime expected utility, choosing each individual's work status and consumption level. Individual consumption C_t^j and labour market choices $h_t^j = \{NW, I, F\}$ are chosen according to spouses' bargaining power, where $j \in \{m, f\}$ indicates the male and female partner within the household, respectively. Individuals can work in the informal (I) sector ($h_t^j = I$), work in the formal (F) sector ($h_t^j = F$) and not work (NW) at all ($h_t^j = NW$). The two-earners' household model provides understanding of the mechanisms used by couples to make choices within the household. Estimating a single-earner model when the household is composed of a couple will bias the estimated self-insurance mechanism and the intertemporal elasticity of substitution. Consideration of the family labour supply allows one to include extra mechanisms to smooth consumption beyond those usually considered in the one-earner consumption and labour

[62] As in the previous section I use a year as the main unit of time. This assumption reduces considerably the computing time necessary to solve the model.

supply models, such as reoptimizing spending and using credit markets in response to shocks. Negative labour shocks for one of the family members can be crowded out with the other family earner labour supply reaction.[63] Modeling households with one individual when family is present rules out a couple's leisure complementarity or substitutability, assuming that spouses' consumption and labour choices do not depend on the other partner's choices. Therefore, the potential unitary model's bias depends among other things on the couple's choices' complementarity or substitutability.[64] On the other hand, modeling household labour choices in a two-earners frame allows one to control for household precautionary labour supply when the total family income uncertainty increases, pooling the income risk within the household. I assume that workers can save and borrow in the financial market according to a constant interest rate $(1 + r)$. Individuals can borrow a fraction of their present value lifetime total earnings. Workers can contribute each period into their individual pensions accounts according to an exogenous contribution rate.[65]

Two-earners' households maximize the following expected lifetime utility function

[63] I am modeling just the extensive margin for the labour supply. Including hours of work could give even more information about the role of the labour supply as a consumption-smoothing mechanism (Blundell et al. [2012]). Modeling the intensive margin of the labour supply is a natural extension of this model.

[64] Gustman and Steinmeier [2004] and Casanova [2011] show that spouses' leisure choices are complement near retirement.

[65] Individuals can save annually voluntary additional amounts, with a cap of US$14400, into their pension accounts for increasing future pensions. I am not currently modeling this system feature.

$$\max_{\{C_t^m, h_t^m, C_t^f, h_t^f\}_t^T} E[\sum_{t=s}^{T} \beta^{t-s} U(C_t^m, h_t^m, C_t^f, h_t^f) + \beta^{T+1} V_{T+1}(P^m, P^f, A_{T+1})]$$

Female and male utility composes the household's utility according to the following structure

$$U(C_t^m, C_t^f, h_t^m, h_t^f) = \lambda U(C_t^m, h_t^m) + (1-\lambda) U^f(C_t^f, h_t^f)$$

Where T is the exogenous age of retirement[66], $0 < \beta < 1$ is the discount factor. Each member's consumption is valued according to the Pareto weight λ, which can be understood as a bargaining parameter (Chiappori and Browning [1998], Chiappori [1992] and Blundell et al. [2005]) within the household. Two-earners' households get instant utility from each earner's consumption and disutility for each earner's positive labour supply choice according to a non-separable and non-homothetic CRRA utility function (Browing and Meghir [1991]) as shown below. Ignoring the non-separability between leisure and consumption could bias the consumption response to permanent wage shocks. The sign of the bias will depend on the substitutability or complementarity between consumption and leisure.

$$U^j(C_{t,}^j h_t^j) = \frac{(C_t^j)^{1-\gamma}}{1-\gamma} exp(\psi_1^j \imath\{h_t^j = I\} + \psi_2^j \imath\{h_t^j = F\}) -$$

[66]The legal age of retirement is 65 for men and 60 for women. However, workers can continue working and contributing after this age. I assume that both retire at 65 as the pension reform allows them to collect welfare pensions just after this age.

$$-\psi_3^j \imath\{h_t^j = I\} - \psi_4^j \imath\{h_t^j = F\}$$

The CRRA function enables me to model risk-averse individuals according to the risk aversion coefficient $\gamma > 1$. Individuals self-insure against expected future negative shocks through precautionary saving and labour supply. I assume that the labour supply disutility cost is sector- and gender-dependent dependent through the coefficients ψ_1^j , ψ_2^j, ψ_3^j and ψ_4^j. The formal sector labour market is on average associated with less time flexibility but at the same time with lower uncertainty. Therefore, conditional on the same wages, individuals with different preferences about these features will self-select in each sector.[67] Working formally or informally generates a consumption independent disutility cost represented by $\psi_3^j > 0$ and $\psi_4^j > 0$, respectively. Marginal consumption utility differs whether individuals do not work or either work formally or informally trough coefficients ψ_1^j and ψ_2^j. $\imath$ is an indicator function, which takes the value of one if the term inside the bracket is true. Workers retire at $T = 65$ years old and finance their pensions from the total accumulated funds. Total utility upon retirement is given by the terminal indirect utility function, V_{T+1}, which depends on each after-retirement-period earner's consumption, financed by the total family assets saved during the working lifetime and individual's pensions.

$$V_{T+1} = \sum_{r=T+1}^{D} \beta^{r-T+1} (\lambda \frac{(C_r^m)^{1-\gamma}}{1-\gamma} + (1-\lambda) \frac{(C_r^f)^{1-\gamma}}{1-\gamma})$$

Households consume during each period upon retirement a constant frac-

[67] I do not model unobserved heterogeneity in the preferences.

tion of the total saved assets at retirement and the total current period withdrawn pensions. Consumption is done according to the number of periods during which retiree will receive the pension, LE[68], and the earner's bargaining power within the household, λ. I assume that all individuals at retirement choose a phased withdrawal pension modality.

Households maximize their problem subject to the assets and pension wealth inter-temporal budget constraints. The former is given by

$$A_{t+1} = (1+r)(A_t - C_t^m - C_t^f + (1-\phi)w_t^{m,F}\imath\{h_t^m = F\} + w_t^{m,I}\imath\{h_t^m = I\} +$$

$$+(1-\phi)w_t^{f,F}\imath\{h_t^f = F\} + w_t^{f,I}\imath\{h_t^f = I\} + nw_t) \quad ; \quad A_{T+1} \geq 0$$

Where A_{t+1} is the total household accumulated financial assets at period $t+1$, ϕ is the 10% tax-deferred exogenous contribution rate that individuals face when they choose to contribute to the pension system, $w_t^{j,F}$ and $w_t^{j,I}$ are the real pos-tax wages received by earner j in the formal and informal sector, respectively, and nw_t is the household non-labour income such as other welfare subsidies. Non-pension savings earn deterministic returns $1 + r$, which are assumed to be equal to 5%. Workers choose then between taxable and liquid assets A_t and tax-deferred and completely illiquid pension saving assets. Compulsory pension savings could crowd out private savings

[68]It is defined according to the average Chilean life expectancy. I take into account the life expectancy by gender, 86 for women and 82 for men.

depending of the relative importance of precautionary savings (Gale and Scholz [19944] and Engen et al. [1996]). I assume that workers consume all financial wealth and pensions during retirement $\sum_{r=T+1}^{D} \beta^{r-T+1}(C_r^m + C_r^f) = A_{T+1} + \sum_{r=T+1}^{D} \beta^{r-T+1}(P_r^m + P_r^f)$, where D is the age of death assumed with certainty. Therefore, bequests are involuntary, and therefore they do not leave any utility. Total assets at retirement must be non-negative $A_{T+1} \geq 0$. The maximum amount that each household can borrow at period t is a fraction θ of the present value of the total future earners' minimum sectoral wages. Thus, maximum household consumption at period t is upper bounded by this borrowing constraint B_t and total household assets at period t.

$$B_t = \theta[\sum_{s=t}^{T} \frac{1}{(1+r)^{s-t}}(min(w_t^{m,F}, w_t^{m,I}) + min(w_t^{f,F}, w_t^{f,I}))]$$

$$0 < C_t^m + C_t^f \leq B_t + A_t$$

Individual total pension wealth at retirement depends on each individual's annual contributions made during the working life, the earned returns due to the financial investment choices made by the PFA[69], the recognition bond RB_t captures any past contributions made in the old PAYG system and the different mechanism introduced by the reform, named WE, such as the child subsidy, the compensation upon divorce and the male survivor pension and

[69]Different according to the multifunds chosen or the compulsory allocated fund by default.

disability insurance new premium. The pension savings intertemporal budget constraint is given by

$$PW_t^j = \sum_{s=0}^{t} \phi w_s^{j,F} \imath\{h_s^j = F\}(1 + r_{pw})^{t-s} + RB_t + WE(child, marr, sex)$$

The reform changes the expected accumulated pension wealth through the different incentives attempting to increase contributions to the system. Those new mechanisms depend on gender (sex), such as the new male survivor pension and the new disability insurance premium, on the number of children ($child$), such as the new child subsidy given to every mother, and on the marital status ($marr$), such as the divorce compensation given to the worse-off member upon divorce. The reform not only changes final pensions at retirement through the self-financed pension wealth at retirement PW_T^j which is defined following the previous equation, but also through the new welfare first tier containing the non-contributory pension PBS and the contributory subsidy APS. Therefore, the final pension wealth differs from the self-financed pension wealth, because the latter only considers the accumulated funds in the individual account and the new mechanism included in WE, while the former takes into account the first tier of the system.[70] Therefore, as I did in Section 2, computing both the self-financed pension wealth, PW_T^j, and the final pension P_s^j, is useful in order to understand the mechanisms by which the reform incentives participate in the system and achieves redistribution.

[70]Workers who did not have enough self-saved pension wealth to self-finance a pension above the PBS but satisfy the means tested requirements such as they obtain a PBS, have implicitly a final pension wealth equivalent to the one to self-finance a PBS.

The final pension is defined as

$$P_s^j = \Gamma(PW_{T+1}^j, pmg_T^j, decil_T) \qquad \forall s > T.$$

It is financed by three main sources. The first two, captured by the accumulated self-saved pension wealth during the working life PW_{T+1}^j new incentives or mechanisms introduced by the reform WE. The last one is the welfare first-tier pension in case the retiree is qualified to receive it. Function Γ refers to the way that the self-saved pension wealth turns on a pension, through a procedure that has been modified with the new welfare pillar introduced by the reform. Variables pmg_T^j and $decil_T$ set the first-tier mean tested conditions. The former indicates the individual accumulated total number of contributions at retirement.[71] Regarding the latter, it indicates to which household income decile the worker belongs at retirement. Welfare pensions could be either the PMG and the PASIS if the worker retires before the reform, and mean-tested conditions are satisfied according to the variables pmg_T^j and $decil_T$, or the PBS and APS[72] if he retires after the reform and belongs to the 60% poorest population, again according to the variable $decil_T$.[73]

Wages are modeled according to the following process

[71]Before reform, workers complying with 20 years of contributions and a self-financed pension lower than the PMG receive this pension at retirement.

[72]The reform sets an annual rate of growth of 3% for the PBS and APS. I assume that the PMAs also grow 3% each year.

[73]Decils are computed using the ITF indicator described in Section 1.5.

$$log(w_{t+1}^{i,j}) = log(w_t^{i,j}) + \nu_t^{i,j} \qquad j \in \{m, f\} \quad i \in \{I, F\}$$

$$\nu_t^{i,j} = \nu_{t-1}^{i,j} + \zeta_t^{i,j} \sim N(\mu, \Sigma_\zeta) \quad ; \quad \Sigma_\zeta = \begin{pmatrix} \sigma^2_{\zeta^{j,F}} & \rho_{\zeta^{j,F},\zeta^{j,I}} \\ \rho_{\zeta^{j,F},\zeta^{j,I}} & \sigma^2_{\zeta^{j,I}} \end{pmatrix} \quad ; \quad \mu_\zeta = \begin{pmatrix} -\sigma^2_{\zeta^{j,F}}/2 \\ -\sigma^2_{\zeta^{j,I}}/2 \end{pmatrix}$$

For each period I assume a permanent gender-sector shock $\zeta_t^{i,j}$, such as a technological shock that makes workers less or more valuable or a health shock that makes workers less productive. I assume a unit root process for $\nu_t^{i,j}$ (MaCurdy [1982], Abowd and Card [1989]). The degree of persistence of income shocks is important. If shocks are *iid* but with a high variance per period, in order to keep the variance of lifetime earnings constant, participation is high across the life cycle as individuals face large amounts of ongoing uncertainty (precautionary labour supply, Low [2005]). With persistent shocks, the uncertainty translates into heterogeneity late in life, having different effects on the timing of labour participation and on the timing of consumption (Meghir and Pistaferri [2010]). Shocks are assumed to be freely correlated across spouses but correlated across sectors. Gender and sectoral wages $w_t^{i,j}$ are not observed for each period-sector. Wages are estimated for each sector, controlling for selection and unobservable heterogeneity using a four-equation system explained in Section 2.2.1. On the other hand, workers not only face uncertainty about the sectoral wages but also regarding future

fertility and marital status.

The household sequential model described above could be written recursively. Beyond age and sex, there is the following household state vector

$Z_t = \{A_t, PW_t^m, PW_t^f, pmg_t^m, pmg_t^f, \zeta_t^m, \zeta_t^f\}$.

$$V_t(Z_t)^{h_t^m \in \{NW,I,F\}, h_t^f \in \{NW,I,F\}} = \max_{c_t^m, c_t^f} [U(C_t^m, C_t^f, h^m = i, h^f = i) + \beta V_{t+1}(Z_{t+1})]$$

Households choose optimally both earners' consumption, C_t^j, conditional to a fixed earners' labour supply choice set $i \in \{NW, I, F\}$ at the current period and the optimal choices in the future represented by the indirect utility function in period $t+1$. Households take into account the probability to divorce[74] Φ_d in the future. They consider the optimal choices made for each earner as a single household in the case of divorce.[75]

$$V_{t+1}(Z_{t+1}) = (1-\Phi_d) * E_t \max(V_{t+1}^{h_{t+1}^m = F, h_{t+1}^f = F}, V_{t+1}^{h_{t+1}^m = F, h_{t+1}^f = I}, ..., V_{t+1}^{h_{t+1}^m = NW, h_{t+1}^f = NW}) \quad +$$

$$+ \quad \Phi_d * [\lambda E_t \max(V_{t+1}^{m, h_{t+1} = F}, V_{t+1}^{m, h_{t+1} = I}, V_{t+1}^{m, h_{t+1} = NW}) \quad +$$

$$+ \quad (1-\lambda) * E_t \max(V_{t+1}^{f, h_{t+1} = F}, V_{t+1}^{f, h_{t+1} = I}, V_{t+1}^{f, h_{t+1} = NW})]$$

The first term is the expected maximum two-earners' household's indirect utility function in period $t+1$ in the case in which spouses remain married,

[74] The probability to divorce is exogenously modeled in Section 2.2.3.

[75] I assume that individuals can divorce and get married just once. Once they have switched their marital status this becomes an absorbent state.

which happens with probability $1-\Phi_d$. The last two terms are the weighed, according to the bargaining power λ, expected maximum single household's indirect utility function for both male and female spouses in the case of divorce, which happens with probability Φ_d. Households choose their two-earners' labour supply comparing their 9 each-period possible consumption optimized indirect utility functions.[76]

$$\{h_t^{*m}, h_t^{*f}\} = argmax[V_t^{h_t^m=F, h_t^f=F}(Z_t), V_t^{h_t^m=F, h_t^f=I}(Z_t), ..., V_t^{h_t^m=NW, h_t^f=NW}(Z_t)]$$

$$\{C_t^{*m}, C_t^{*f}\} = C(Z_t, h_t^{*m}, h_t^{*f})$$

For every possible state value, the model is solved backward from period T. I use an equally spaced uniform grid for A_t and PW_t^j. Expected values

[76]Individual state vector is defined as $Z_t^j = \{A_t, PW_t^j, pmg_t^j, \zeta_t^j\}$. Conditional on the labour market decision $h_t^j = i \in \{NW, I, F\}$ individual chooses consumption according to the following Bellman equation.

$$V_t(Z_t^j)^{i\in\{NW,I,F\}} = \max_{c_t}[u(C_t^j, h_t^j = i) + \beta V_{t+1}^j(Z_{t+1}^j)]$$

Where

$$V_{t+1}^j(Z_{t+1}^j) = E_t \max(V_{t+1}^{h_{t+1}^j=F}, V_{t+1}^{h_{t+1}^j=I}, V_{t+1}^{h_{t+1}^j=NW})$$

labour market participation is chosen when comparing the obtained consumption optimized indirect utility functions.

$$h_t^{j*} = argmax[V_t^{h_t^j=I}(Z_t^j), V_t^{h_t^j=F}(Z_t^j), V_t^{h_t^j=NW}(Z_t^j)]$$

$$C_t^{j*} = C(Z_t^j, h_t^{j*})$$

$$E_t \max(V_{t+1}^{h_{t+1}^m=F,h_{t+1}^f=F}, V_{t+1}^{h_{t+1}^m=F,h_{t+1}^f=I}, ..., V_{t+1}^{h_{t+1}^m=NW,h_{t+1}^f=NW})$$

were solved using Gauss-Hermite quadratures and indirect utility functions $V_{t+1}^{h_t^m=\{.\},h_t^f=\{.\}}$ were interpolated using linear interpolation methods. Numerical complexities are coming not only because the dimension of this problem is relatively large but also because its structure generates non-concavities in the value function. The combination of discrete (labour supply) and continuous (consumption) choices generates multiple kinks in the value function even if the analysis in every period is done conditional to the labour supply choice. For a good description of this numerical complexity, see Attanasio et al. [2008]. On the other hand, the welfare tier of the pension system creates flat sections on the terminal value function, which generates more kinks in the other periods' value functions. One strategy to overcome this issue is to solve the problem separately to any section between kinks. However, this strategy implies a large amount of time. I solve the model using a grid for each earner's consumption, which enables me to skip the difficulties due to the non-concavities. Once optimal consumption is chosen, then each earner's labour supply is optimized as a standard discrete choice model.

3.2 Baseline Parameters.

In this subsection I discuss the choice of some exogenous or external parameters used to solve and estimate the model. Such choices are based in the preexisting literature and observed data. I assume a real interest rate for the non-pension savings equal to 5%.[77] The discount factor is set to 0.98,

[77]I assume this based on the annual return of the Chilean 30-year central government

implying a lower discount rate than the interest rate. The annual pension wealth PW_t return was calibrated according to the historical multifunds data returns. As I explained briefly in Section 2, workers can choose among 5 funds with different combinations of risk and return. When workers do not choose any funds their savings are invested among three default funds defined by age. I assume different interest rates by age according to the default multifunds structure (Section 2). As age increases, the funds' risk decreases. Returns on fund B, C and D are assumed to be equal to 11%, 9% and 7%, respectively. These choices are consistent with the average return of the last 20 years of the Chilean DC system, which has been around 9% (CRP [2006]). In particular, I observe whether workers have chosen a specific fund in the year 2009; for these cases I assume that individuals will hold the same fund for all remaining ages defining the current workers' default fund.[78] The next table summarizes the calibrated coefficients.

bonds.

[78]I do not control for interest rate risk uncertainty. This is important for the assets allocation and portfolio choice. Different interest rate uncertainty between the pension wealth savings and private savings will affect the optimal portfolio choice made between them.

Table 14: Calibrated Coefficients

Calibrated Coefficients	Value
Interest rate $(1+r)$	1.05
Discount factor (β)	0.98
Risk aversion (γ)	1.5
Interest rate PW r_b, r_c, r_d	0.11,0.09,0.07
Retirement Age (T)	65
Life expectancy (LE) - Men(Women)	82(86)
Annual non-labor income (nw) (log)	12
Contribution Rate (ϕ)	0.1
PBS (monthly)	US$ 165
PMG (monthly)	US$ 212
PASIS(monthly)	US$ 119
Estimated Coefficients (outside the model)	
Standard dev. shock F - Women σ_{ζ^F}	0.13
Standard dev. shock I - Women σ_{ζ^I}	0.15
Standard dev. shock F - Men σ_{ζ^F}	0.10
Standard dev. shock I - Men σ_{ζ^I}	0.11
Formal-informal correlation - Both $\rho_{\zeta^{F,I}}$	0.09

I assume that all workers retire at 65 years old. After retirement $s > T$ workers stay at home, $h_s^j = NW$, and consume pensions and non-pension savings, as I explained before. Following the official Chilean mortality tables, the female and male life expectancy is assumed to be 86 and 82 years, respectively. Risk-aversion coefficient γ is assumed to be equal to 1.5 in the utility function, which gives an inter-temporal elasticity of substitution according to the literature (Attanasio and Weber [2010]). The standard deviations for formal income innovations are assumed to be equal to 0.13 and 0.10 for women and men, respectively. For the informal sector, the innovations' standard deviation are assumed equal to 0.15 and 0.11 for women and men, respectively (Hyslop [2001], Meghir and Pistaferri [2010], Attanasio et al. [2008]). The correlation coefficient between the two sectors shocks is equal to 0.09. The PBS, PMAs pension are assumed to grow at 3% per

year, as the regulation has defined. The PMG and PASIS growth is set at 2% according to their historical data.

3.3 Results.

3.3.1 Estimations.

I estimate the model by Simulated Method of Moments (SMM) (McFadden [1989]). I match observed data for each age of the female and male labour life cycle profile between 35 and 65 years old. The following moments are matched:

1. The average labour market participation of women and men for each year of the life cycle profile.

2. The average formal labour market participation of women and men for each year of the life cycle profile.[79]

3. The average proportion of women working in the formal labour market within the household for each year of the life cycle profile.

A total of 186 moments are matched using two stages SMM. The combination of continuous and discrete choices generates a non-smooth non-linear objective function, which does not make it possible to minimize using a gradient optimizer solver.[80] I minimize the objective function using a direct-search

[79] I match the fraction of employees working formally over the economically active population.

[80] Indirect inference (Keane and Smith [2003]) could be used to smooth the objective function through the use of an auxiliary model. Even though those auxiliary models could be extremely simple, such as a probability model, this makes the problem less tractable,

method. I estimate all gender-sectoral preference coefficients ψ_1^j, ψ_2^j, ψ_3^j and ψ_4^j, the borrowing constraint coefficient θ and the intrahousehold bargaining power coefficient λ. Household choices are governed by the pre-reform scheme up until 2008 and by the post-reform structure from 2008. The model is estimated considering pre-reform data and then including post reform data. Table 15 shows the estimated coefficients.

Table 15: Estimated Coefficients

Variable	Coeff BR	△ Coeff BR-AR
Marginal female informality cost ψ_1^f	0.05	0.00
	(0.020)	
Marginal male informality cost ψ_1^m	0.04	0.00
	(0.004)	
Marginal female formality cost ψ_2^f	0.07	0.02*
	(0.080)	
Marginal male formality cost ψ_2^m	0.02	0.01
	(0.015)	
Female Informality cost ψ_3^f	2.12	0.01
	(0.090)	
Male Informality cost ψ_3^m	1.23	0.40
	(0.040)	
Female Formality cost ψ_4^f	2.02	0.00
	(0.030)	
Male Formality cost ψ_4^m	0.85	0.01
	(0.013)	
Bargaining coefficient λ	0.64	0.03**
	(0.160)	
Borrowing coefficient θ	0.12	0.00
	(0.020)	

significance *10%**5%***1%

Coefficients ψ_3^j and ψ_4^j, reflecting the cost associated with participating in the informal and formal sector, take values equal to 2.12 and 2.02 for women and to 1.23 and 0.85 for men, respectively. The results show that the labour disutility is larger for the informal sector than for the formal sector, $\psi_4^j < \psi_3^j$,

as extra estimations are required in each solving iterations.

for both genders. Workers prefer to work in the formal sector, conditional on receiving the same wages. The informal sector is generally associated with more flexibility, but at the same time with more uncertainty as it is related with short-term jobs. As the sectoral disutility difference is larger for men than women, it seems that labour stability is more appreciated for male workers. This reflects the fact that men should receive consumption compensation larger than women in order to work in the informal sector. labour market participation costs associated with a rise in the family could explain this difference in preferences.[81] Parameters ψ_3^f and ψ_4^f for women correspond to a utility cost of participating in the labour market equivalent to CLP$ 938,000 (US$ 2,064) and CLP$ 112,7000 (US$ 2,480).

On the other hand, we can see that, for both sectors, the consumption marginal utility is greater for women than for men. Coefficients ψ_1^j and ψ_2^j, reflecting the reduction in the consumption utility while working in the informal and formal labour sector, respectively, take values equal to 0.05 and 0.07 for women and equal to 0.04 and 0.02 for men. As $\gamma > 1$, $\psi_1^j > 0$ and $\psi_2^j > 0$ the marginal utility of consumption is larger when participating than when not participating for both sectors. This result reflects the fact that both consumption and labour supply are complements in utility (Low [2005], Attanasio et al. [2008], Klaauw [1996]). Negative permanent income shocks will not only impact the labour supply and consumption directly but will also affect the latter indirectly through this complementarity. Therefore, models considering separable utility function underestimate the consumption

[81] Modeling children-dependent labour market participation cost is one possible extension of this model.

response to income changes due to a permanent shock such as a pension reform.

The parameter λ determines spouses' sharing rule of resources within the household and then their incentives to participate in the labour market and to save. I exploit the fact that the reform changes the relative female position within the household exogenously to gain identification of the bargaining power coefficient change. Therefore, the responses in the spouses' behavior, such as the fraction of married women working in the formal sector, due to the pension reform, is crucial to provide identification of the change of λ. It is expected that the female formal labour market participation response to the reform would be decreasing in the men Pareto weight bargaining power. The larger the male decision power, through a large bargaining power λ, the lower the labour female response to changes in her pension. This can be explained by a transfer of resources from the wife to the husband due to the reform. As spouses' income are consumed by household's member according to the sharing rule, any female pension improvement increases the husband's available resources. The estimated bargaining power coefficient with pre-reform date is equal to 0.64, meaning that the male bargaining power within the household is almost double than female one. When estimations are done including the post-reform data, the estimated coefficient λ decreases to 0.61, showing that the reform has increased the female bargaining power by 0.3 points.

The estimated model matches the observed data well for most of the age groups, with the exception of the last part of the male life cycle. The average female formal labour market participation is about 30%. The low female

labour market participation, and therefore the associated low participation in the pension system, has been one of the main problems of the Chilean labour market. Needless to say, this has implied the lack of contributions explaining the low female replacement rates reproduced by the DC system and the high fiscal burden associated with the low female accumulated pension wealth and consequently with the related welfare pensions. On the other hand, the male formal labour market participation has been historically higher than the female one. The fraction of men working in the formal sector is on average around 55%. The next table reports the fraction of economically active people working in the formal sector by age and gender considering those periods in which I observe data. I compare the obtained results using the estimated model and those coming from the observed data.

Table 16: Model Fit

Simulated and Observed Formality

	Women		Men	
	Model	**Data**	**Model**	**Data**
Age				
36-40	36.4%	37.7%	56.3%	61.5%
41-45	34.1%	35.1%	65.0%	60.3%
45-50	34.4%	33.4%	58.7%	58.3%
51-55	32.3%	32.0%	61.5%	55.0%
56-60	23.8%	22.8%	54.9%	50.2%
61-65	9.8%	7.9%	38.4%	48.6%
Average	28.5%	28.1%	55.8%	55.6%

Formality is measured as the fraction of population economically active contributing to the pension system.

Modeling labour choices within the household is important to understand how spouses react to their partner's income shocks. Even though the pension

reform affects to women more significantly than men, as we will see in the next section, it can impact the male labour market outcomes, as pension income is pooled within the household.

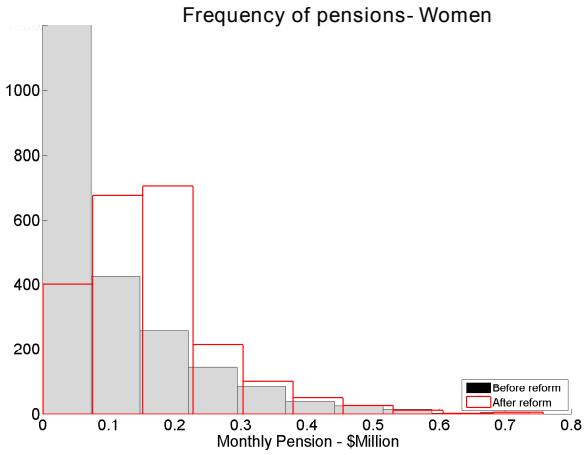
The next subsections show the main reform impacts. I compute first the effects of the reform on the frequency of final pension income at retirement. Secondly, I estimate the effects of the reform on formal labour market participation. Finally, I show how the reform changes pensions differently for different cohorts and by gender, impacting the original inequalities originated by the pre-reform system.

3.3.2 Reform effects on final pensions.

As I mentioned in Section 1, the reform targets specifically certain groups, such as women in their childbearing periods and young employees. Therefore, total pension and pension wealth changes are different across population groups. For instance, as some of the subsidies were specifically targeted to women, we can expect a higher improvement for the final female pensions than the male pensions. This statement is strongly supported when the pension frequency before and after the reform is compared for each gender. The next figure shows the female pension frequency before and after the reform. The reform increases substantially the female pension received at retirement. Those women who do not belong to the first poorest decile of the population and thus do not qualify for the PASIS pension were withdrawing low pensions under the pre-reform scenario. This group, together with those women receiving a PASIS pension, explains the large female pension density

between zero and CLP$ 100,000 (US$ 220), observed in Figure 26. Before the reform, the average monthly simulated female pension was CLP$ 113,076 (US$ 248) , increasing to CLP$ 164,603 (US$ 362) after the reform.

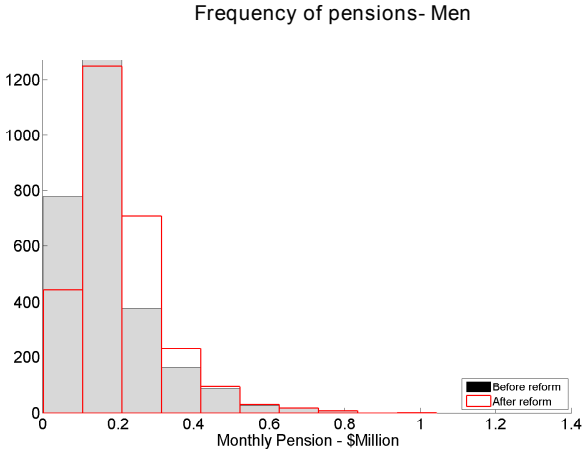
Figure 26: Female Pension Before and After the Reform



Even though final pensions increase for men and women, the change in their frequency is larger for female pensions, reducing importantly the gap between them.[82] The gender monthly pension difference is CLP$ 33,655 (US$ 74) and CLP$ 24,299 (US$ 53) before and after the reform, respectively. Previously to the reform, the male pension distribution has been historically characterized by a bimodal distribution, where the two modes have been given by the PASIS and the PMG welfare pensions. The next figure shows the frequency of the monthly simulated male pension at retirement. The male pension increases on average CLP$ 42,164 (US$93), with a pre-reform average value of CLP$146,732 (US$323).

[82] Accomplishing satisfactorily one of the main goals of the reform.

Figure 27: Male Pension Before and After the Reform



The long-term and short-term effects of the reform are unlikely to be the same. The main reason to expect differences is that the impact of the reform depends on how advanced a cohort was in its life cycle. These differences arise both because of the provisos in the new law for individuals who already had some seniority and because older individuals have fewer years to adapt their accumulations to the new legislation These effects are particularly important in the context of the 2008 reform, because younger cohorts will have more time to react to the elements introduced by the reform. The next two figures show the frequency of the amount of monthly pensions, measured in CLP$ million, before and after the reform for female[83] workers belonging to the cohorts born in the 1940s and the 1960s. The first group is composed of workers who are retiring between 2005 and 2015[84] and then it is the first group of employees retiring under the post-reform new frame. The 1960 cohort group, composed of employees who will retire around 2025-2035, is

[83]The same graphs for men are in the Appendix B, Section B.1

[84]I only consider those who have not retired in 2009 yet.

the first group that will retire having contributed their entire working life in the DC system. For both groups, the final pension will increase importantly after the reform. The average female pension change is CLP$ 27,271 (US$ 60) for those workers belonging to the 1940 cohort and CLP$ 59,778 (US$ 131) for those belonging to the 1960 cohort, representing an increment of 33% and 47% of the final pension before reform, respectively.

Figure 28: Female Pension Cohort 40

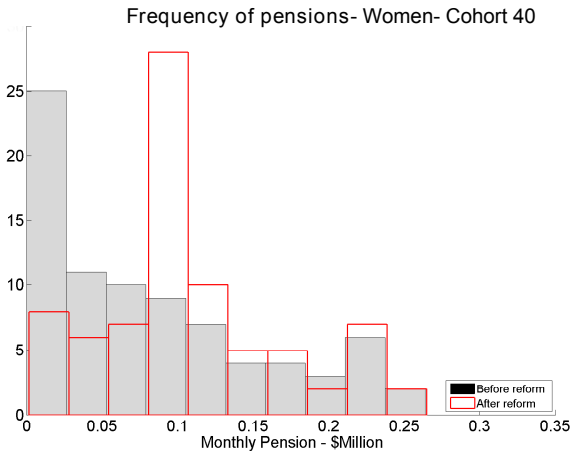
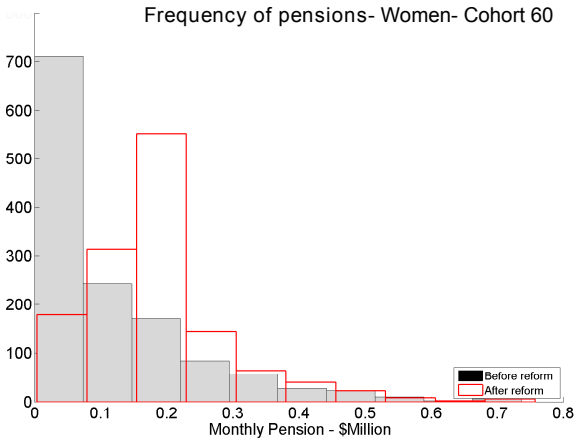
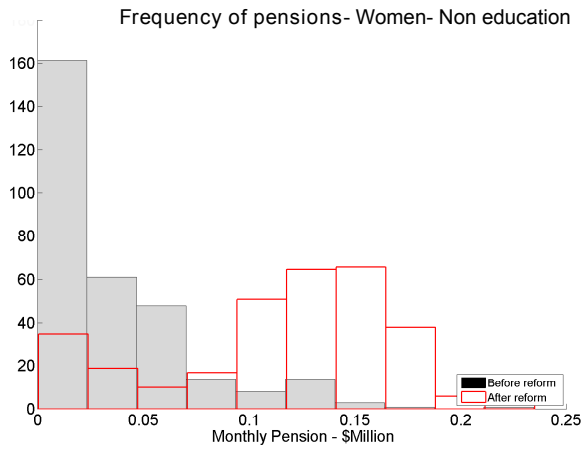


Figure 29: Female Pension Cohort 60



As long as the first-tier reform affects particularly workers with low self-financed pensions, because they will qualify for the new welfare pension subsidies (PBS and APS), the change in the final pension should be larger for them. The next two figures show the pension frequency for workers without formal education or incomplete primary school and for those who got a college degree, respectively.[85] Even though the differences between both groups are still very important after the reform, a significant gap reduction can be observed, as the increment of the pension is clearly more important for non-educated workers.

Figure 30: Female Pension - Non Education



[85]The pension frequency for the workers with primary and secondary levels of education are in the Appendix B, Section B.1.

Figure 31: Female Pension - College

The next section shows how formal labour market participation is affected by the reform.

3.3.3 Labour market participation effects.

The new welfare tier, through the PBS and the APS, changes the incentives for each individual to participate in the pension system. This will primarily depend on the worker's and her spouse's pre-reform situation. For instance, workers who were receiving a PASIS pension before the reform will eventually receive the PBS pension after the reform. However, workers who do not receive a PASIS but have the same self-financed pension wealth than the previous group will potentially, conditional to belonging to the 60% poorest population, receive the new non-contributory pension. The reform effects for these two same self-saved pension wealth groups of workers will differ because the pension income and the accrual pension rate change will be different for each one. The new incentives could be understood as income and substitution effects largely documented in the literature. As I discussed previously,

a negative income effect can be expected for those workers who were receiving a PASIS pension and are currently receiving a PBS pension. However, as the PBS is complemented with the APS top-up subsidy, the same group of workers has incentives to contribute for additional years, as they will receive a higher additional pension due to the subsidy for any extra saved dollar. Before the reform, those individuals receiving the PASIS and the PMG faced an implicit marginal tax rate of 100% on their contributions. Any additional contribution does not increase the final pension at retirement.[86] After the reform, that implicit marginal tax rate is reduced through the APS subsidy, generating a positive substitution effect which will increase the probability to participate in the formal labour market sector. These two effects drive the final labour supply reaction for each individual. Moreover, the final total aggregate effect will depend on the relative magnitude of each effect and the distribution of the individuals in the budget constraint represented by Figure 1.[87] The results show that the new incentive-compatible subsidy APS does not fully offset the negative income effect due to the higher expected pension at retirement. The reform reduces the coverage of the pension system. The fraction of women and men working formally decreases on average 6.4% and 3.3%, respectively.

The next table shows the simulated final effect on formal labour market participation by age and sex in the year 2015. The reform impact is larger for women than men. The average fraction of women and men older than 60

[86]At least the extra contribution increases the self-financed pension such as the new self-financed pension will be larger than the current either received PASIS or PMG or the required number of contributions in order to receive a PMG is satisfied.

[87]Simulated budget constraint graphs can be found in the Appendix B, Section B.2.

years old working in the formal sector decreases about 2.75% and 2.34% due to the reform, respectively. The reform's impact on formal labour market participation change across the life cycle profile. These differences are given not only due to the different changes in the accrual rate and expected pension wealth for each cohort but also because younger workers discount largely the future pension, reducing its expected values.

Table 17: Labour Market Reform Effects

Reform Impact - Formality Change - 2015

	Women	Men	Total
Age			
41-45	-10.18%	-4.29%	-7.37%
45-50	-7.56%	-5.30%	-6.31%
51-55	-6.01%	-2.16%	-3.89%
56-60	-4.14%	-6.17%	-5.12%
61-65	-2.75%	-2.34%	-2.51%
Education			
Non education	-11.57%	-13.98%	-12.66%
Primary	-7.76%	-4.27%	-6.17%
Secondary	-6.80%	1.41%	-2.62%
College	-1.85%	5.83%	1.51%
Average	-6.37%	-3.30%	-4.77%

Formality is measured as the fraction of population economically active contributing to the system.

Therefore, even though the changes introduced by the reform are larger for younger workers, the final effect will depend not only on how those changes are valued at different ages but also on the magnitud of the marginal effect affecting the labour supply choices. The reform reduces on average the fraction

of people contributing to the pension system by 4.8%.

3.3.4 Redistributional effects.

Defined contribution pension schemes tend to replicate inequalities observed in the labour market. As final pensions depend primarily on the total accumulated pension wealth during the working lifetime, individuals with poorer earnings and lower labour market attachment will finish with low pensions. Moreover, considering that women retire younger and have longer life spans than men, gender inequality in pensions will be even higher than the gender income inequality. On the other hand, if a sizeable fraction of the population participates in the informal labour market, inequality in pensions can be even higher if contributions to formal schemes have tax advantages. In the same way I did in Section 2, I focus now on specific measures of inequality. In particular, I report the level of the Gini coefficient, the standard deviation of logs, as well as ratios of different quantile of the pension and pension wealth distribution for both men and women. Table 18 shows some figures for the distribution of the pension at retirement.

Table 18: Pension Inequality Measures

Inequality Measures Final Pension - Before and After Reform								
	P90/P10 BR	P90/P10 AR	P75/P25 BR	P75/P25 AR	St.dev. BR	St.dev. AR	Gini BR	Gini AR
Women								
Cohort 1940	3.78	1.87	2.17	0.50	3.62	0.74	0.48	0.28
Cohort 1950	3.54	2.29	2.01	0.82	2.71	0.96	0.55	0.36
Cohort 1960	2.87	1.53	1.45	0.41	1.14	0.64	0.44	0.26
Total	3.17	1.83	1.75	0.62	2.00	0.81	0.48	0.31
Men								
Cohort 1940	2.05	1.78	0.85	0.70	2.10	0.77	0.36	0.31
Cohort 1950	2.20	1.30	1.04	0.55	0.85	0.62	0.39	0.27
Cohort 1960	2.13	1.32	0.96	0.54	0.84	0.63	0.38	0.27
Total	2.19	1.43	1.01	0.65	1.04	0.68	0.39	0.29

The reform implies a reduction in inequality for men as well as women. The overall Gini goes from 0.48 to 0.31 for men and 0.39 to 0.29 for women, closing importantly the gender gap observed previously to the reform. The first two columns in Table 19 contains the 90/10 percentile ratio indicator. They show us the large pension tail dispersion for the older female cohorts. This dispersion is just a mirror of the historical labour market conditions. We can see that, before and after the reform, the gender gaps are considerably reduced.

I report the same measures of inequality for the self-saved accumulated pension wealth in Table 19. As I mentioned before, this does not take into account the first tier and the redistributive role that it plays and focuses only on the predicted amount in the individual accounts upon retirement. Comparison of the inequality indicators considering both variables allows me

to isolate the effects of the first-tier reform from the other elements associated with the contributory tier. Even neglecting the effect of Tier 1 and the redistributive role it plays, the reform reduces the amount of inequality in accumulated pension wealth for women.

Table 19: Pension Wealth Inequality Measures

Inequality Measures Final Pension Wealth - Before and After Reform

	P90/P10 BR	P90/P10 AR	P75/P25 BR	P75/P25 AR	St.dev. BR	St.dev. AR	Gini BR	Gini AR
Women								
Cohort 1940	4.16	4.30	2.60	2.47	3.66	1.62	0.58	0.51
Cohort 1950	3.57	3.31	1.95	1.75	2.70	1.24	0.58	0.52
Cohort 1960	3.14	2.54	1.67	1.33	1.22	0.98	0.54	0.56
Total	3.36	2.87	1.85	1.50	2.01	1.14	0.56	0.52
Men								
Cohort 1940	2.23	2.27	0.90	0.93	2.09	2.10	0.45	0.45
Cohort 1950	2.45	2.51	1.21	1.24	0.95	1.06	0.43	0.43
Cohort 1960	2.33	2.46	1.08	1.14	0.91	1.75	0.42	0.43
Total	2.37	2.49	1.22	1.25	1.11	1.59	0.44	0.45

The overall Gini coefficient for women is reduced from 0.56 to 0.52. For men, instead, there are virtually no changes in inequality in accumulated pension wealth. These results are explained by the fact that the changes in accumulated wealth induced by the reform are mainly driven by the child subsidies, the divorce regulations, and the other elements I discussed. It is remarkable that they not only reduce the inequality between men and women but also inequality among women.

The inequality measures in Table 18 are considerably lower than those in Table 19. Moreover, the reduction due to the first tier is more pronounced

after the reform than before. For instance, if we compare the Gini coefficient for women in Tables 18 and 19, it goes from 0.56 for pension wealth to 0.48 for pension entitlements before the reform. The same figures after the reform are 0.52 and 0.31: the first tier after the reform implies a 22 point reduction in the Gini coefficient when going from pension wealth to pension. Before the reform, the same reduction was only 8 points.

3.4 Reduced form and structural model comparison.

This section compares the results obtained using the structural model approach with the reduced form approach estimated in Section 2. The latter estimates the propensity to contribute to the pension system using a discrete non-linear model with the expected pension wealth at retirement and the accrual rate as regressors. These two variables, which capture the income and the substitution effect discussed previously, are computed for each individual using the forecasted future wages and probabilities to work formally and the pension system's rules. Once both variables are computed under the pre- and post-reform, they are instrumentalized, exploiting the fact that the reform affects different groups of the population differently, such as young people and both genders. The probability to work formally is estimated according to a non-linear discrete model comparing the results under the pre- and post-reform scenarios. This methodology shows explicitly how the additional pension wealth due to the reform reduced the propensity to contribute to the pension system. However, it does not take into account the fact that current changes in formal labour market participation, due to the exogenous changes in both the pension wealth and the accrual rate introduced by the

reform, will affect final pensions. In order to take into account this, a fully structural model is necessary to control for this behavioral effect. On the other hand, the reduced-form approach used in Section 2 does not control for intrahousehold allocation and possibly uneven gender bargaining power. Considering a spouse's bargaining power within the household is important to determine the effects of pension on consumption and labour choices, as pension income is consumed by household's member according to the sharing rule. The larger pension frequency showed in Section 3.3.2 increases not only wife's resources at retirement but also her husband's resources. This effect depends crucially on the bargaining power coefficient λ.

The average male and female pension change using the fully structural model is 1.8% and 0.01% larger than the results obtained using the reduced form approach, respectively. On the other hand, both the structural model and the reduced form approach show that the probability to contribute to the pension system has decreased as a result of the reform. The latter estimates a 0.4% lower change in formal labour market participation for those workers older than 40 years old. The income effect, through the new pension wealth, is under both methodologies, not completely offset by the substitution effect generated by the changes in the accrual rate. The average female formal labour market reduction estimated by the reduced form approach is 1.2% lower than the reduction estimated by the structural model. However, the estimated male formal labour market reduction is 0.5% larger. These differences are in line with the fact that men have a larger bargaining power within the household, according to the estimations.

4 Conclusion

This thesis studies the relationship between pension incentives and informal labour market participation evaluating an important pension reform in a defined contribution pension system. Demographic changes such as a lower number of workers per retirees have triggered many countries to revise their pension systems. Defined contribution pension systems have been either proposed or implemented across Europe and the United States as an alternative to those fiscally unsustainable PAYG systems. However, in many countries where a DC system has been operating for a while, particularly in Latin America, the replacement rates have been below the initial expectations. On the other hand, the DC systems tend to replicate labour market inequalities, and those workers, such as women, with low labour market attachment, finish with poor pensions. Moreover, if a sizeable fraction of the population chooses to participate in the informal labour market, in order to avoid contributions to the system, the fiscal burden will increase.

DC systems usually mandate individuals to contribute a fraction of their periodical wages into individual accounts. These contributions earn returns and are finally mapped on pensions at retirement. Therefore, individuals accrue pension wealth each period according to their contributed wages and the associated returns for that contributions. The accrual mechanism combined with the welfare elements of the system generate particular incentives to contribute to the system and then work formally. Since the 1980s, Chile has had a DC system, being one the pioneering countries to set a fully funded pension system. However, after 30 years, the system has not accomplished

some of the original expectations. In particular, replacement rates have been below those expected. Therefore, in 2008, Chile implemented its largest pension system reform since the DC system started in the early 1980s. The reform sought to prevent old-age poverty, to guarantee a minimum and stable level of consumption upon retirement and to reduce those inequalities generated by the DC scheme. It modifies completely the welfare tier of the system, introducing several mechanisms to foster contributions, recognizing gender differences and improving 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 by a flat unique pension PBS, and a pension wealth-decreasing subsidy APS impacting the 60% of the poorest retired population over 65 years old. Additionally, several new subsidies and mechanisms, such as the child subsidy, the divorce compensation mechanism, the new survivor male pensions and the female disability and survivor insurance were implemented, targeting different groups. Therefore, the pension reform changes the expected pension at retirement through the new welfare tier in place and secondly through the various mechanisms introduced to complement the contributory tier. On the other hand, the accrual rate also changed before and after the reform due to the new welfare pensions introduced. These two elements, the change in the expected pension wealth at retirement and the expected change in the accrual rate, could be understood as an income and substitution effect affecting labour supply choices. These changes are different for different groups of the population not only because some of the new incentives are explicitly targeted towards specific groups but also because the younger cohorts have more time to react

optimally to the reform. We can expect not only important changes in the expected accumulated pension wealth due to the reform but also differences across groups for those changes. Therefore, from a theoretical point of view, the reform has an ambiguous effect on participation in the formal labour market. The individual effects on the labour market depends on the worker's pre-reform situation and how the final pension and the accrual rate changed due to the reform. When aggregating the income and the substitution effect, it is possible to determine the empirical final total effect on the individual formal labour market participation due to the reform.

The thesis evaluates the effects of the reform using both, a reduced form approach through a control function methodology and a structural model solving and estimating a two earner's household consumption, labour supply and pension saving model. Both gives us evidence about the relationship between pension incentives and formal labor market participation in a DC pension system. On the other hand, the both methodologies comparison allows me to extent the bias size on the reform's effect estimation when looking forward behavior is not considered. Therefore, highlighting the relevance of considering fully structural model when complex policy reforms are evaluated.

The first section shows the main features of the Chilean pension system and explains carefully the 2008 Chilean pension reform. The reform introduces important elements, changing the pension incentives and modifying formal labor market participation. The welfare tier of the system was completely modified. A contributory minimum pension was replaced by a non-contributory flat pension and a decreasing on self-saved pension wealth

subsidy. At the same time, different elements were introduced in the second system's pillar. A child subsidy, a compensation upon divorce and new structures for the disability insurance and survivor pension were implemented.

Section 2 finds that the overall effect on the probability to contribute to pension system is negative as a result of the reform, reducing the participation in the formal labour market by around 4.1% for those workers older than 40 years old. The results differ by gender and age. The reform reduces the probability of being formal by 3.2% and 2.8% for women and men between 56 and 65 years old, respectively. This section gives us a good benchmark to compare the results obtained with a fully behavioral model.

Section 3 solves and estimates a dynamic consumption, labour supply and pension-saving accumulation life cycle structural model. It complements the existing literature by incorporating the choice of two sectors in the labour market, the formal and informal labour sectors, and allowing for intrahousehold bargaining power. Households choose individuals' sector labour supply and consumption in an environment with uncertainty given by sectoral wage shocks, future marital status and future fertility choices. The model allows workers to borrow against non-pension savings, considering current and future intrahousehold allocation in consumption and labour supply and future possibilities to divorce, marriage and the birth of more children. Bargaining power within the household determines sharing rules for the total pooled resources. I estimate the Pareto weight coefficient, exploiting the fact that the reform changes exogenously the relative female position within the household. The female formal labour market response within the household due to the reform is then crucial to gain identification of the bargaining power

coefficient.

Few studies have tried to quantify the reform effects so far. Even though all of them find a negative effect of the reform on formal labour market participation, they either do not control or control only partially for behavioral effects. They do not incorporate the effect of the new current labour market choices, and eventually future labour choices, due to the reform on future pensions at retirement. Without a fully structural model that allows forward-looking behavior, it is not possible to control for this endogenous process between pensions at retirement and the complete life cycle path of labour choices. In this sense, Section 3 considers how labour choices are driven by future pension at retirement, which at the same time is determined by the current and future labour market choices.

The final main results are threefold: First, the reform has increased not only the self-financed pension wealth, due to the different mechanisms or subsidies received during the accumulation period, but has also 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 increases by on average 0.3% and 22%, respectively. Secondly, the new incentives introduced by the reform have reduced formal labour market participation. The probability to contribute to pension system has decreased as a result of the reform, reducing formal labour market participation by around 4.2% for those workers older than 40 years old. The results are significantly higher for women. The reform reduces the probability of being formal by 2.7% and 2.3% for women and men between 61 and 65 years old, respectively. Thirdly, even though the final pension changes have been posi-

tive for both gender, the female pension improvement has been 32% higher than the rise for men, reducing importantly the gender inequalities. The first tier after the reform implies a 17-point reduction in the Gini coefficient. Before the reform the same reduction was only 6 points. The estimated bargaining power coefficient with pre-reform date is equal to 0.64, meaning that the male bargaining power within the household is almost double that of females. When estimations are done including the post-reform data, the estimated male bargaining power within the household decreases to 0.61, showing that the reform has increased female bargaining power by about 0.3 points.

Thirdly, the estimates from the reduced-form methodology are somewhat different; for workers over 60, the reform is estimated to have a 0.2% larger effect on formal labour market participation, whereas for younger workers between 41 and 45 years old, the estimate is 3% smaller. The main reason to explain this it is that the trade-off, in terms of pension wealth improvements and formal labour market participation, that the new subsidies and welfare pensions have raised is not considered by the reduced-form strategy. The larger pensions due to the reform have reduced the incentives to work formally, through a direct negative income effect which is not offset by the positive substitution effect given by the changes in the accrual rate. This trade-off raises the point about the optimal subsidies and welfare pensions' role in designing the optimal incentives to increase participation in the pension systems, reducing fiscal burden, and guaranteeing minimum levels of consumption for retirees.

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A Appendix Section 2

A.1 First Stage.

Table 20: First Stage Estimations - A

First Stage Estimations - Linear Panel Data RE			
	(1)	(2)	(3)
VARIABLES	Pension Wealth	Pension Wealth	Pension Wealth
Age	1.4509***	1.4357***	1.3946***
	[0.1619]	[0.1621]	[0.1611]
Age2	-0.0184***	-0.0184***	-0.0179***
	[0.0018]	[0.0018]	[0.0018]
Sex (1=Men)	11.3664***	11.2741***	11.2823***
	[0.4219]	[0.4156]	[0.4162]
Primary (1=Yes)	6.2561***	6.2024***	6.2021***
	[0.5287]	[0.5171]	[0.5184]
Secondary(1=Yes)	12.6418***	12.5339***	12.5327***
	[0.5824]	[0.5696]	[0.5711]
Degree(1=Yes)	23.0542***	22.8575***	22.8493***
	[0.5769]	[0.5644]	[0.5658]
Married (1=Yes)	0.5231***	0.4992**	0.4974**
	[0.2020]	[0.2018]	[0.2018]
Sex*Married	1.1103***	1.1706***	1.1718***
	[0.2778]	[0.2776]	[0.2775]
Number Children 0-3	-0.3199**	-0.3389**	-0.3356**
	[0.1327]	[0.1329]	[0.1328]
Number Children 4-5	-0.2135*	-0.2325*	-0.2298*
	[0.1277]	[0.1280]	[0.1279]
Number Children 6-13	0.8387***	0.8331***	0.8378***
	[0.1041]	[0.1041]	[0.1040]
Number Children 14-18	0.6442***	0.6385***	0.6387***
	[0.1045]	[0.1046]	[0.1045]
Sex*Number Children 0-3	-0.1107	-0.0882	-0.0951
	[0.1789]	[0.1791]	[0.1790]
Sex*Number Children 4-5	-0.3217*	-0.2986*	-0.3011*
	[0.1733]	[0.1736]	[0.1735]
Sex*Number Children 6-13	-0.6473***	-0.6361***	-0.6465***
	[0.1349]	[0.1349]	[0.1348]
Sex*Number Children 14-18	-0.5601***	-0.5502***	-0.5570***
	[0.1375]	[0.1376]	[0.1375]
Trend	0.7695***	0.7740***	0.7689***
	[0.1292]	[0.1277]	[0.1279]
Cohort 1950*Year 2003	0.4911	0.5011	0.4967
	[0.5301]	[0.5314]	[0.5311]
Cohort 1960*Year 2003	-0.3778	-0.3822	-0.3784
	[0.5198]	[0.5211]	[0.5207]
Cohort 1970*Year 2003	-1.5666***	-1.4914***	-1.4804***
	[0.5300]	[0.5312]	[0.5309]
Cohort 1980*Year 2003	-0.8627	-0.6862	-0.6200
	[0.6778]	[0.6799]	[0.6792]
Cohort 1950*Year 2004	-0.3185	-0.2406	-0.2762
	[0.5326]	[0.5346]	[0.5335]
Cohort 1960*Year 2004	-1.3010**	-1.2529**	-1.2673**
	[0.5312]	[0.5330]	[0.5321]

Table 21: First Stage Estimations - B

First Stage Estimations - Linear Panel Data RE

Cont. VARIABLES	(1) Pension Wealth	(2) Pension Wealth	(3) Pension Wealth
Cohort 1970*Year 2004	-1.8143***	-1.7116***	-1.7013***
	[0.5564]	[0.5578]	[0.5571]
Cohort 1980*Year 2004	-1.6727**	-1.4084**	-1.3801*
	[0.7077]	[0.7103]	[0.7089]
Cohort 1950*Year 2005	-0.9162*	-0.6572	-0.7645
	[0.5383]	[0.5431]	[0.5393]
Cohort 1960*Year 2005	-2.2319***	-2.0004***	-2.0885***
	[0.5508]	[0.5547]	[0.5516]
Cohort 1970*Year 2005	-2.5727***	-2.3171***	-2.3685***
	[0.5986]	[0.6015]	[0.5992]
Cohort 1980*Year 2005	-2.8160***	-2.3351***	-2.4224***
	[0.7592]	[0.7632]	[0.7603]
Cohort 1950*Year 2006	-1.1229**	-0.9065*	-1.0080*
	[0.5362]	[0.5395]	[0.5371]
Cohort 1960*Year 2006	-2.7733***	-2.6064***	-2.6711***
	[0.5690]	[0.5717]	[0.5695]
Cohort 1970*Year 2006	-3.2888***	-3.1208***	-3.1418***
	[0.6458]	[0.6476]	[0.6459]
Cohort 1980*Year 2006	-3.7117***	-3.2830***	-3.3248***
	[0.8169]	[0.8194]	[0.8174]
Cohort 1950*Year 2007	-1.3381**	-1.1844**	-1.2820**
	[0.5459]	[0.5491]	[0.5467]
Cohort 1960*Year 2007	-3.3853***	-3.2811***	-3.3260***
	[0.6023]	[0.6049]	[0.6026]
Cohort 1970*Year 2007	-3.9969***	-3.9099***	-3.8935***
	[0.7110]	[0.7130]	[0.7107]
Cohort 1980*Year 2007	-4.4291***	-4.1087***	-4.1424***
	[0.8971]	[0.8996]	[0.8969]
Cohort 1950*Year 2008	-0.0415	0.1580	0.0110
	[0.5542]	[0.5599]	[0.5549]
Cohort 1960*Year 2008	0.1794	0.2818	0.2049
	[0.6380]	[0.6428]	[0.6381]
Cohort 1970*Year 2008	1.7375**	1.8437**	1.8451**
	[0.7813]	[0.7848]	[0.7806]
Cohort 1980*Year 2008	2.8824***	3.3786***	3.2973***
	[0.9853]	[0.9895]	[0.9849]
Cohort 1950*Year 2009	-0.1972	-0.0112	-0.1462
	[0.5638]	[0.5700]	[0.5645]
Cohort 1960*Year 2009	-0.0474	0.0448	-0.0094
	[0.6778]	[0.6829]	[0.6777]
Cohort 1970*Year 2009	1.8029**	1.8465**	1.8765**
	[0.8568]	[0.8612]	[0.8558]
Cohort 1980*Year 2009	3.1952***	3.5280***	3.4385***
	[1.0803]	[1.0846]	[1.0791]
Sex*Year 2003	0.0862	0.0647	0.0595
	[0.2035]	[0.2040]	[0.2039]

Table 22: First Stage Estimations - C

First Stage Estimations - Linear Panel Data RE

Cont.	(1)	(2)	(3)
VARIABLES	**Pension Wealth**	**Pension Wealth**	**Pension Wealth**
Sex*Year 2004	0.3816*	0.3749*	0.3766*
	[0.2035]	[0.2040]	[0.2039]
Sex*Year 2005	0.5867***	0.5916***	0.5858***
	[0.2043]	[0.2048]	[0.2047]
Sex*Year 2006	0.8697***	0.8789***	0.8706***
	[0.2019]	[0.2024]	[0.2023]
Sex*Year 2007	1.1487***	1.1457***	1.1465***
	[0.2028]	[0.2032]	[0.2031]
Sex*Year 2008	-3.9729***	-4.0226***	-4.0209***
	[0.2037]	[0.2042]	[0.2041]
Sex*Year 2009	-3.5061***	-3.5280***	-3.5324***
	[0.2046]	[0.2051]	[0.2050]
Accrual Rate* Group Age <25		0.3462***	
		[0.0282]	
Accrual Rate* Group Age 26-30		0.4015***	
		[0.0229]	
Accrual Rate* Group Age 31-35		0.5833***	
		[0.0271]	
Accrual Rate* Group Age 36-40		0.6741***	
		[0.0351]	
Accrual Rate* Group Age 41-45		0.7638***	
		[0.0495]	
Accrual Rate* Group Age 46-50		0.9918***	
		[0.0750]	
Accrual Rate* Group Age 51-55		0.8891***	
		[0.1026]	
Accrual Rate* Group Age 56-60		1.3115***	
		[0.1694]	
Accrual Rate* Group Age 61-65		2.0004***	
		[0.3462]	
Accrual Rate	0.5069***		-0.2876***
	[0.0143]		[0.0634]
Accrual Rate*age			0.0257***
			[0.0020]
Constant	-24.1849***	-23.3128***	-22.6547***
	[4.5164]	[4.4601]	[4.4557]
Observations	59,497	59,497	59,497
Number of folio	7,877	7,877	7,877

Standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1 . We control for time and cohort dummies.

A.2 Second Stage.

Table 23: Male Second Stage Estimations

Dicrete Choice Model Estimations - Pr. to Contribute=1			
Men			
Variables	**NO IV**	**IV**	**CF**
Age	-0.0761***	0.0161	0.0233*
	[0.0218]	[0.0342]	[0.0122]
Age2	0.0011***	0.0001	0.0061***
	[0.0002]	[0.0004]	[0.0010]
Primary (1=Yes)	0.2990***	0.7908***	0.3381***
	[0.0806]	[0.1282]	[0.0473]
Secondary(1=Yes)	0.4179***	1.3808***	0.6522***
	[0.0936]	[0.2122]	[0.0912]
Degree(1=Yes)	0.2332**	1.8485***	0.9973***
	[0.0981]	[0.3521]	[0.1672]
Married	0.2433***	0.3973***	0.4663***
	[0.0458]	[0.0528]	[0.0531]
Number Children 0-3	0.0950***	0.0860**	0.0702***
	[0.0337]	[0.0347]	[0.0199]
Number Children 4-5	0.0737**	0.0510	0.0218
	[0.0337]	[0.0349]	[0.0227]
Pension Wealth	0.0509***	0.0016	-0.0078
	[0.0046]	[0.0143]	[0.0070]
Pension Wealth*Age	-0.0007***	-0.0013***	-0.0004***
	[0.0001]	[0.0003]	[0.0001]
Accrual Rate	-0.1226***	-0.1808***	-0.1900***
	[0.0281]	[0.0297]	[0.0193]
Accrual Rate*Age	0.0061***	0.0095***	0.0085***
	[0.0009]	[0.0011]	[0.0006]
Constant	0.9235***	1.0259***	
Observations	32,719	32,719	32,719

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.

A.3 Marginal Effects.

Table 24: Marginal Effects Estimations

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

VARIABLES	(1) IV-RE-PwWomen	(2) IV-RE-PwMen	(3) CF-PwWomen	(4) CF-PwMen
Age	0.1601***	-0.0484	0.0574***	0.0188
	[0.0478]	[0.0404]	[0.0163]	[0.0149]
Age2	-0.0019***	0.0009*	-0.0007***	-0.0002
	[0.0006]	[0.0005]	[0.0002]	[0.0002]
Married (1=Yes)	-0.4128***	0.3755***	-0.3631***	0.4861***
	[0.0514]	[0.0524]	[0.0181]	[0.0532]
Number Children 0-3	-0.3662***	0.0911***	-0.2304***	0.0694***
	[0.0392]	[0.0349]	[0.0213]	[0.0200]
Number Children 4-5	-0.2003***	0.0535	-0.1201***	0.0192
	[0.0386]	[0.0349]	[0.0249]	[0.0227]
Number Children 6-13	-0.1810***	0.0326	-0.1177***	0.0685***
	[0.0337]	[0.0245]	[0.0129]	[0.0169]
Number Children 14-18	-0.0030	-0.0190	0.0022	0.0389**
	[0.0338]	[0.0267]	[0.0149]	[0.0168]
Pension Wealth* Group Age <25	-0.0505**	-0.0313**	-0.0333***	-0.0216***
	[0.0198]	[0.0142]	[0.0089]	[0.0072]
Pension Wealth* Group Age 26-30	-0.0358*	-0.0259*	-0.0262***	-0.0185***
	[0.0189]	[0.0138]	[0.0084]	[0.0069]
Pension Wealth* Group Age 31-35	-0.0337*	-0.0318**	-0.0224***	-0.0216***
	[0.0191]	[0.0139]	[0.0087]	[0.0071]
Pension Wealth* Group Age 36-40	-0.0392**	-0.0367***	-0.0263***	-0.0234***
	[0.0195]	[0.0140]	[0.0088]	[0.0071]
Pension Wealth* Group Age 41-45	-0.0380*	-0.0398***	-0.0272***	-0.0282***
	[0.0206]	[0.0145]	[0.0092]	[0.0073]
Pension Wealth* Group Age 46-50	-0.0376*	-0.0477***	-0.0239**	-0.0304***
	[0.0213]	[0.0147]	[0.0094]	[0.0073]
Pension Wealth* Group Age 51-55	-0.0376*	-0.0532***	-0.0262***	-0.0329***
	[0.0225]	[0.0153]	[0.0097]	[0.0075]
Pension Wealth* Group Age 56-60	-0.0603**	-0.0674***	-0.0268***	-0.0383***
	[0.0241]	[0.0159]	[0.0101]	[0.0077]
Pension Wealth* Group Age 61-65	-0.0650**	-0.0718***	-0.0338***	-0.0412***
	[0.0285]	[0.0173]	[0.0110]	[0.0083]
Accrual Rate* Group Age <25	0.1513***	0.0510***	0.1164***	0.0308***
	[0.0195]	[0.0116]	[0.0162]	[0.0085]
Accrual Rate* Group Age 26-30	0.1393***	0.0669***	0.1196***	0.0357***
	[0.0167]	[0.0116]	[0.0111]	[0.0075]
Accrual Rate* Group Age 31-35	0.0937***	0.1210***	0.0990***	0.0609***
	[0.0185]	[0.0170]	[0.0112]	[0.0097]
Accrual Rate* Group Age 36-40	0.2226***	0.1674***	0.2971***	0.1135***
	[0.0290]	[0.0227]	[0.0191]	[0.0150]
Accrual Rate* Group Age 41-45	0.1902***	0.1825***	0.3438***	0.1735***
	[0.0337]	[0.0278]	[0.0234]	[0.0188]
Accrual Rate* Group Age 46-50	0.1772***	0.2900***	0.3434***	0.2473***
	[0.0424]	[0.0482]	[0.0300]	[0.0302]
Accrual Rate* Group Age 51-55	0.4150***	0.3999***	0.7338***	0.3551***
	[0.1024]	[0.0708]	[0.0617]	[0.0478]
Accrual Rate* Group Age 56-60	1.0861***	0.8238***	1.1277***	0.7503***
	[0.2108]	[0.1387]	[0.1215]	[0.0927]
Accrual Rate* Group Age 61-65	0.1594	0.4257***	0.5860**	0.3939***
	[0.3006]	[0.1651]	[0.2885]	[0.1173]

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.

A.4 Scenarios.

Table 25: Male Marginal Effects Estimations - Scenarios

Marginal Effects Probit Dicrete Choice Model Estimations - Men - Probability to Contribute=1					
	(1)	(2)	(3)	(4)	(5)
VARIABLES	Pr=0.1	Pr=0.3	Pr=0.5	Pr=0.7	Pr=0.9
Age	0.0462***	0.0413**	-0.0731***	-0.0243	-0.0242
	[0.0158]	[0.0167]	[0.0197]	[0.0189]	[0.0204]
Age2	-0.0004**	-0.0004**	0.0007***	0.0004**	0.0004**
	[0.0002]	[0.0002]	[0.0002]	[0.0002]	[0.0002]
Married (1=Yes)	0.4739***	0.3039***	0.3900***	0.1164***	0.0745
	[0.0402]	[0.0329]	[0.0456]	[0.0448]	[0.0571]
Number Children 0-3	0.0287	0.5643***	0.7548***	0.1660*	0.0493
	[0.0198]	[0.0570]	[0.0869]	[0.0891]	[0.1159]
Number Children 4-5	-0.0144	0.8733***	1.2282***	-0.0564	-0.3633
	[0.0229]	[0.1103]	[0.1741]	[0.1886]	[0.2660]
Number Children 6-13	0.0841***	0.4722***	0.5740***	0.1592**	0.0756
	[0.0159]	[0.0418]	[0.0609]	[0.0656]	[0.0859]
Number Children 14-18	0.0757***	0.0333*	0.0419**	0.0465**	0.0570***
	[0.0178]	[0.0197]	[0.0195]	[0.0198]	[0.0208]
Pension Wealth* Group Age <25	-0.0455***	-0.0467***	-0.0342***	0.0209*	0.0296*
	[0.0071]	[0.0069]	[0.0088]	[0.0109]	[0.0159]
Pension Wealth* Group Age 26-30	-0.0274***	-0.0233***	-0.0315***	0.0256**	0.0352**
	[0.0057]	[0.0057]	[0.0090]	[0.0108]	[0.0156]
Pension Wealth* Group Age 31-35	-0.0352***	-0.0267***	-0.0343***	0.0240**	0.0351**
	[0.0059]	[0.0059]	[0.0091]	[0.0107]	[0.0155]
Pension Wealth* Group Age 36-40	-0.0373***	-0.0279***	-0.0381***	0.0246**	0.0337**
	[0.0060]	[0.0060]	[0.0091]	[0.0108]	[0.0155]
Pension Wealth* Group Age 41-45	-0.0409***	-0.0336***	-0.0431***	0.0232**	0.0325**
	[0.0063]	[0.0062]	[0.0092]	[0.0107]	[0.0155]
Pension Wealth* Group Age 46-50	-0.0404***	-0.0339***	-0.0451***	0.0208*	0.0343**
	[0.0064]	[0.0064]	[0.0092]	[0.0107]	[0.0156]
Pension Wealth* Group Age 51-55	-0.0404***	-0.0376***	-0.0498***	0.0186*	0.0322**
	[0.0067]	[0.0066]	[0.0094]	[0.0106]	[0.0155]
Pension Wealth* Group Age 56-60	-0.0420***	-0.0426***	-0.0552***	0.0124	0.0300*
	[0.0070]	[0.0069]	[0.0096]	[0.0107]	[0.0155]
Pension Wealth* Group Age 61-65	-0.0507***	-0.0452***	-0.0637***	-0.0004	0.0189
	[0.0078]	[0.0076]	[0.0103]	[0.0117]	[0.0160]
Accrual Rate* Group Age <25	0.4894***	0.5042***	0.0985***	0.1416***	0.1773***
	[0.0296]	[0.0301]	[0.0264]	[0.0251]	[0.0321]
Accrual Rate* Group Age 26-30	0.2222***	0.1783***	0.0415***	0.0297	0.0315
	[0.0172]	[0.0155]	[0.0091]	[0.0197]	[0.0323]
Accrual Rate* Group Age 31-35	0.3315***	0.2010***	0.0928***	0.0712**	0.0434
	[0.0236]	[0.0169]	[0.0133]	[0.0295]	[0.0487]
Accrual Rate* Group Age 36-40	0.4637***	0.2732***	0.2238***	0.0838***	0.1171*
	[0.0300]	[0.0223]	[0.0234]	[0.0288]	[0.0634]
Accrual Rate* Group Age 41-45	0.6002***	0.4272***	0.3368***	0.1165***	0.2010***
	[0.0385]	[0.0311]	[0.0322]	[0.0283]	[0.0614]
Accrual Rate* Group Age 46-50	0.6641***	0.4303***	0.3637***	0.1676***	0.1461**
	[0.0504]	[0.0379]	[0.0379]	[0.0446]	[0.0593]
Accrual Rate* Group Age 51-55	0.6673***	0.7925***	0.6022***	0.2085***	0.3852***
	[0.0558]	[0.0652]	[0.0575]	[0.0499]	[0.0764]
Accrual Rate* Group Age 56-60	0.8329***	1.1362***	1.1311***	0.4922***	0.3032**
	[0.0811]	[0.1038]	[0.1135]	[0.1125]	[0.1404]
Accrual Rate* Group Age 61-65	1.5722***	1.0209***	1.5152***	1.5054***	1.1451***
	[0.1852]	[0.1450]	[0.1908]	[0.4056]	[0.2861]
Residual	0.0415***	0.0405***	0.0542***	-0.0198*	-0.0293*
	[0.0067]	[0.0066]	[0.0097]	[0.0119]	[0.0163]

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.5 Outcomes of interest

A.5.1 Changes in the frequency of pensions resulting from the reform.

Figure 32: Male Frequency of Pensions - Cohorts

Figure 33: Female Frequency of Pensions - Cohorts

Figure 34: 1960 Cohort Frequency of Pensions-Educational Groups

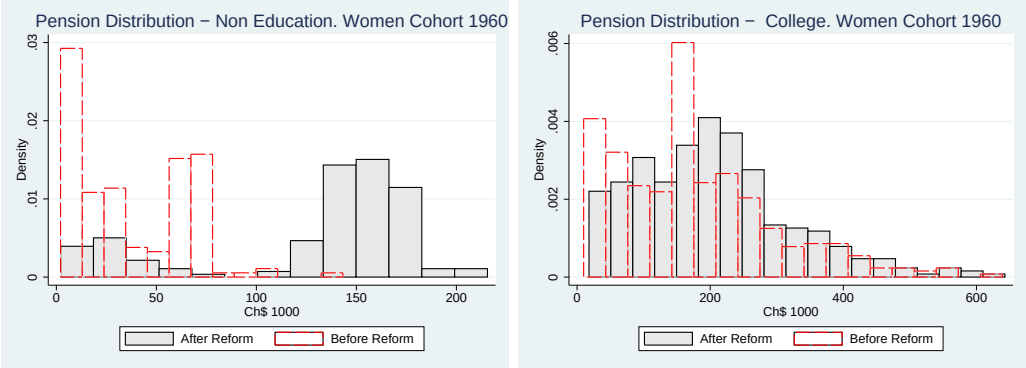


Figure 35: 1960 Cohort Frequency of Pensions-Educational Groups

A.5.2 Changes in the frequency of the gender pension differences.

Figure 36: Frequency of Pension Change

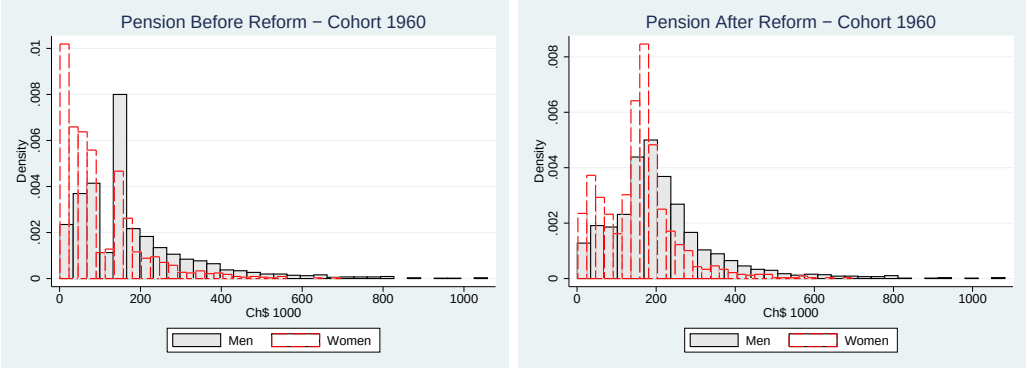


Figure 37: Pension Change Distribution - Non education and Primary

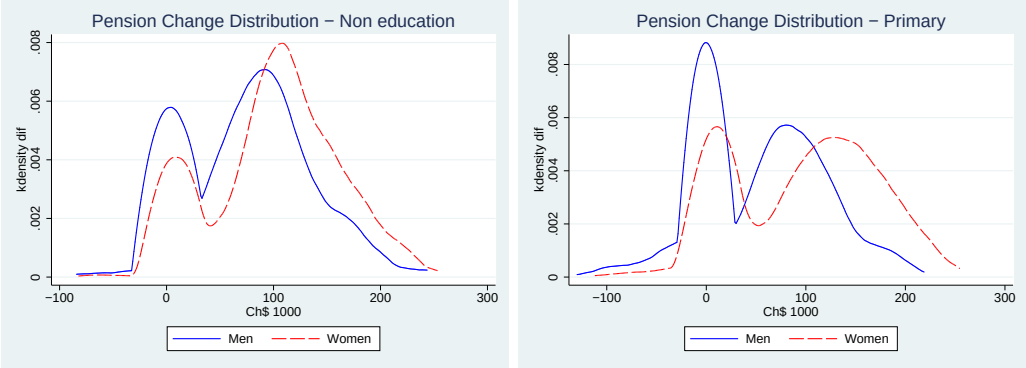
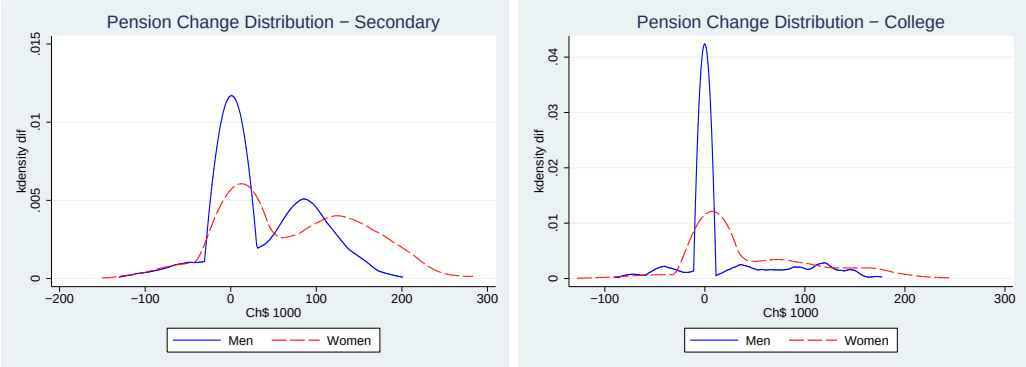


Figure 38: Pension Change Distribution - Secondary and College



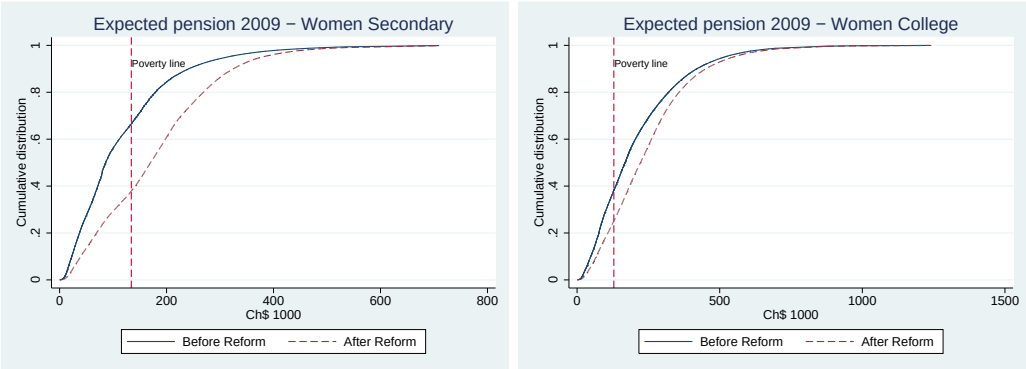
A.5.3 Changes in accumulated pension wealth before and after the reform.

Figure 39: Frequency of Pension Wealth - Non Education and Primary

Figure 40: Frequency of Pension Wealth - Secondary and College

A.5.4 Changes in poverty levels before and after the reform for elderly people, in particular, for elderly women.

Figure 41: Female Cumulative Pension - Secondary and College



A.5.5 Changes in the probability to contribute and changes in the frequency of contributions.

Figure 42: Female Forecasted Probability to Contribute - 1950 and 1960 Cohort

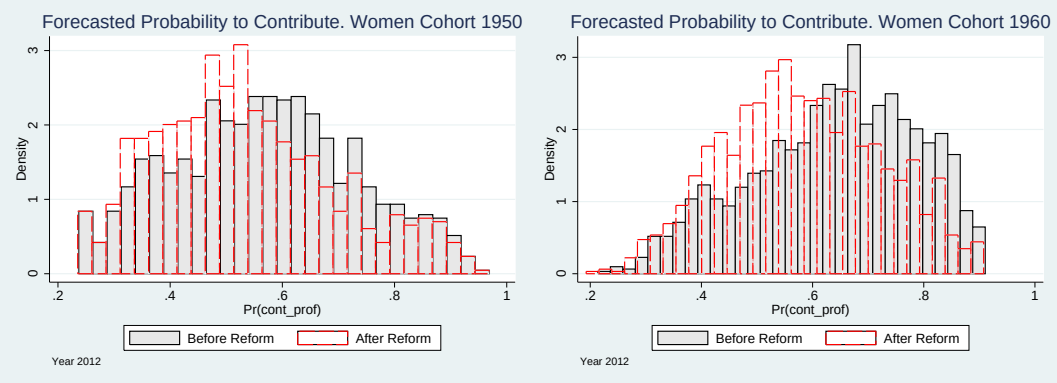
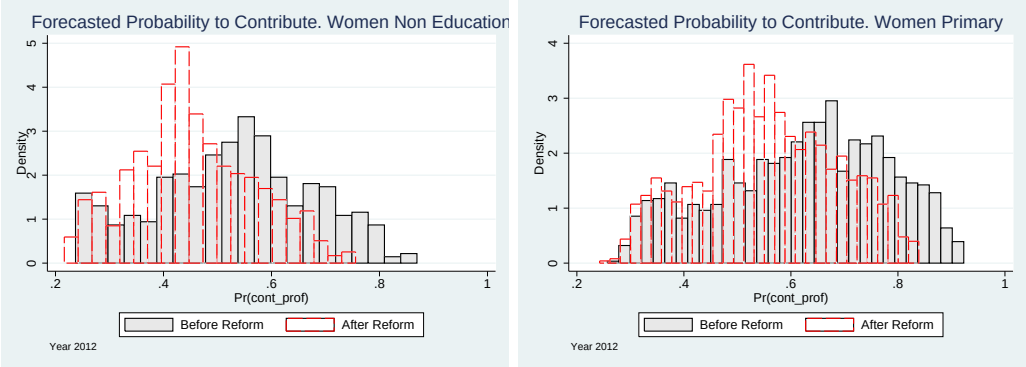


Figure 43: Female Forecasted Probability to Contribute - Non education and Primary



A.5.6 Pension Changes, Accrual Rate Changes and Coverage

Table 26: Pension and Accrual Rate Change

Pension (PW) and Accrual Rate (AC) Change - Year 2009

Group	Mean PW	Mean Acc Rate
Men		
<25	$12,500,000	-$478,629
26-30	$11,300,000	$51,657
31-35	$9,244,713	-$32,915
36-40	$8,740,925	-$63,674
41-45	$7,686,302	-$29,754
46-50	$6,122,648	-$92,115
51-55	$5,427,073	-$65,444
56-60	$4,457,318	-$40,498
61-65	$2,623,618	-$7,612
Women		
<25	$38,900,000	$165,512
26-30	$22,300,000	-$62,928
31-35	$17,900,000	-$296,651
36-40	$16,100,000	-$103,695
41-45	$13,600,000	-$369
46-50	$9,660,732	-$44,272
51-55	$7,652,520	-$5,493
56-60	$5,680,208	-$40,710
61-65	$4,816,598	-$246,054

Table 27: Budget Constrain Frequency

BUDGET CONSTRAIN GROUPS					
Group	**PASIS**	**PMG-HAPS**	**PMG-LAPS**	**SELF-APS**	**SELF**
Men					
2008-2012	2.89%	9.31%	0.00%	26.93%	60.87%
2013-2017	7.32%	11.13%	0.00%	34.42%	47.14%
2018-2022	7.28%	11.32%	0.00%	37.20%	44.20%
2023-2027	7.44%	11.44%	3.76%	34.39%	42.98%
2028-2032	7.76%	11.73%	7.45%	36.82%	36.24%
2033-2037	6.02%	17.94%	9.76%	30.02%	36.26%
2038-2042	4.40%	15.35%	10.92%	29.50%	39.83%
2043-2047	5.39%	21.70%	15.85%	25.34%	31.72%
Women					
2008-2012	11.62%	10.71%	0.00%	33.46%	44.22%
2013-2017	12.23%	4.93%	0.00%	31.85%	50.98%
2018-2022	9.56%	8.24%	0.00%	31.85%	50.34%
2023-2027	14.07%	6.91%	4.96%	33.24%	40.81%
2028-2032	15.80%	6.75%	5.76%	40.59%	31.09%
2033-2037	16.98%	10.96%	5.26%	35.38%	31.42%
2038-2042	16.30%	10.78%	5.89%	34.73%	32.31%
2043-2047	14.85%	8.35%	4.28%	40.94%	31.58%

B Appendix Section 3

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

Next tables show the frequency of the male pension income before and after the reform for different cohorts and educational groups.

Figure 44: Male Frequency of Pensions by Cohort

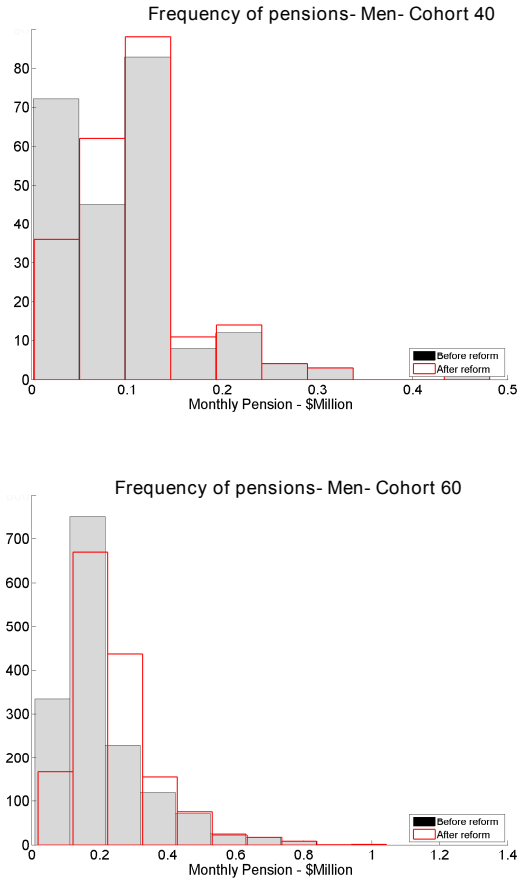
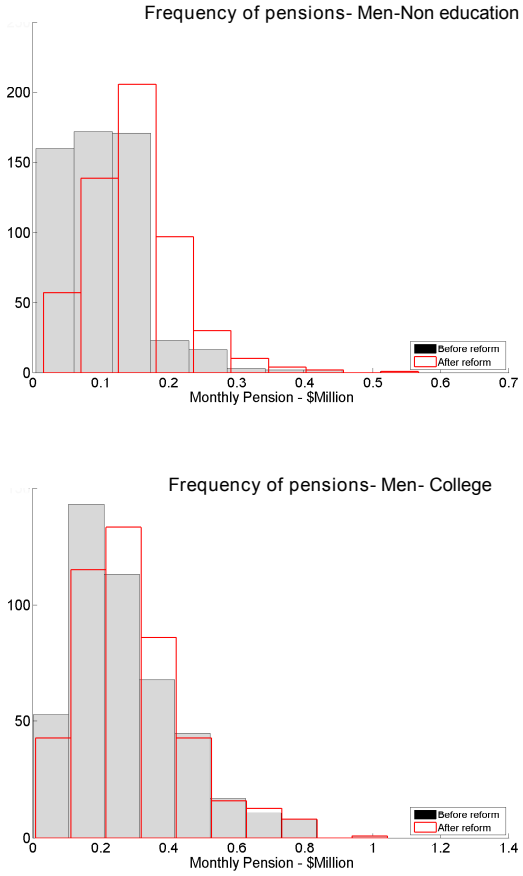


Figure 45: Male Frequency of Pensions by Educational Groups



B.2 Budget constraint simulations.

The next two Figures show the empirical simulated budget constraints which were explained in Section 1. We can observe important dispersion in the final pension income for the same self-saved pension wealth. This happens because individuals are retiring at different periods and welfare pensions after the reform, PBS and APS, and before the reform, PMG and PASIS, are assumed to growth each period 3% and 2%, respectively. We can observe that final allocations are different for men and women, which is explained

not only due to differences in the self-financed pension wealth but also in the comply of the mean tested requirements enabling them to qualify for the welfare tier.

Figure 46: Female Budget Constraint

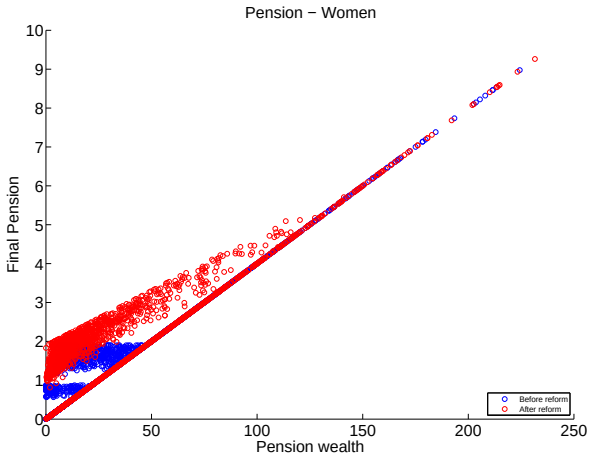
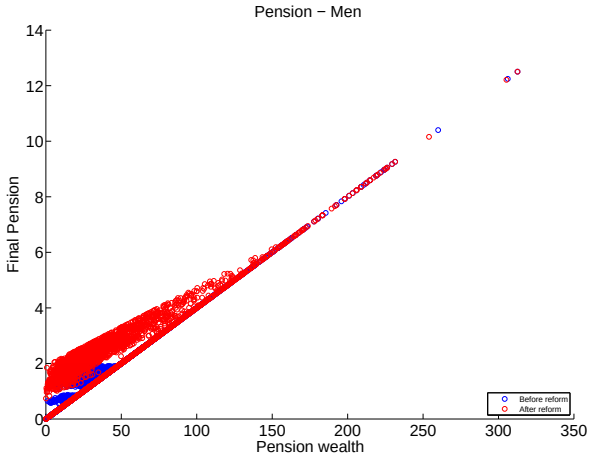


Figure 47: Male Budget Constraint



C Assumptions

1. Sample. Non-retired AFP (No INP) workers between 20 and 65 years old.

2. Retirement age: I am assuming that all individuals will retire at 65 years old. There is not early retirement.

3. Interest rate: I assume different interest rates by age according the default multi-funds structure, where Fund B return =11%, Fund C return=9% and Fund D return=7%. I observe if workers have chosen a fund in year 2009, in these cases I assume that individuals will hold the same fund for all remaining ages defining the current workers' default fund.

4. Recognition bond: Individuals that contributed to the old PAYG system (pre-80s) will receive at retirement a bond (RB) recognizing those contributions. I am assuming a $RB´s$ annual real return equal to 4.5% . For individuals who have not claimed the RB I do not observe its value. For those cases I am imputing average values by age, education and gender groups.

5. Discount factor: I am assuming a discount factor equal to 0.98.

6. PMG/PASIS/PBS and PMAS values: For the welfare pensions before (PMG and PASIS) and after (PBS and PMAS) the reform I am using the following CLP$ values defined by law: PASIS=CLP$ 44,186;

PMG=CLP$96,391; PBS=CLP$75,000; PMAS=CLP$70,000 at 2008, CLP$120,000 at 2009, CLP$150,000 at 2010, CLP$200,000 at 2011 and CLP$255,000 at 2012 onwards.

7. PBS and PMAs growth: I am assuming an annual rate of growth equal to 2% and 3% for the PMG and PASIS, respectively.

8. I am assuming a gender disability premium rate difference equal to 0.2%.

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

10. Minimum wage: Starting from the 2009 Minimum Wage equal to CLP$ 165,000 I am assuming an annual rate of growth equal to 3%.

11. Cap contributions: 64 UF (CLP$20,319) at 2009. UF is an unit of account used in Chile. The exchange rate between the UF and the Chilean peso is constantly adjusted to inflation.

12. Pensions: All retirees are choosing a phased withdrawal pension modality at retirement.