

Impact of Social Security Reform on Labor Force Participation Rates of Pensioners and Non-pensioners: Evidence from Chile

by

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Abstract

Recent research has argued that incentives stemming from social security systems influence the worker's decision to retire. The experience of Chile, which radically changed its system in 1981, offers an opportunity to test this hypothesis. Using probit analysis and simulations of the behavior of 50 cohorts followed through 47 household surveys, we estimate the impact of the 1981 pension reform on the probability of dropping out of the labor force, for older workers. We find large effects: Labor force participation rose dramatically among male cohorts that approached retirement age after 1981, in contrast to the decline observed before. Three different components of the reform potentially account for this increase: exempting pensioners from the pension payroll tax and eliminating work restrictions they previously faced, moving toward actuarial fairness for non-pensioners by the adoption of a market-based defined contribution system, and tightening early retirement restrictions. We find evidence for all three effects. Exemption of pensioners from the pension payroll tax seems most important.

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Impact of Social Security Reform on Labor Force Participation Rates of Pensioners and Non-pensioners: Evidence from Chile

Labor force participation of older men has declined in many countries during recent decades. This has decreased the available supply of human capital and increased the fiscal problems of pension programs. A considerable literature has developed on the extent to which incentives stemming from social security systems have contributed toward this decline or can help reverse it. The experience of Chile, which radically changed its system in 1981, offers an opportunity to test whether large system changes produce large labor supply changes. We are not aware of any previous study addressing this impact of the Chilean reform.¹

Prior to 1981 Chile had a traditional pay-as-you defined benefit (DB) system that included disincentives to work among older individuals, similar to those found in many European countries today. Contribution rates were high, allowable pension ages low and benefits didn't change commensurately with incremental contributions, postponed pensions or increased longevity. Workers had strong incentives to start their pensions as soon as possible because this maximized their lifetime net benefits, and labor force participation dropped dramatically when pensions started. This changed with the 1981 reform, which replaced the DB system with a defined contribution (DC) system and included several other important changes expected to raise the labor force participation rates of older individuals.

We seek to measure the over-all impact of the reform on labor force participation rates (LFP) and pension age, and to disentangle the effects that are due to early pension constraints, which could be imposed in a DB system, versus those that are due to incentives to continue contributing and working, which stem from the move toward actuarial fairness in the new system. Actuarial fairness has several separable dimensions,

depending on the return to incremental contributions, the reward for postponing the initial pension and the adjustment for a longer expected lifetime. To analyze the impact of the new system, we distinguish among these dimensions and we exploit differences in the rules that apply to pensioners versus non-pensioners and between individuals over and under age 65. We expect that actuarial fairness should have the following effects:

(1) The exemption of pensioners from the pension payroll tax (making contributions voluntary, hence completely fair actuarially) and the elimination of restrictions on their continued work should increase incentives for pensioners to work; this is the most clear-cut prediction.

(2) Giving market returns to incremental contributions by non-pensioners (a move toward partial actuarial fairness) should increase incentives for non-pensioners to work; this impact should be smaller than that for pensioners but greater for non-pensioners over 65, who are exempt from the payroll tax.

(3) The actuarially fair return to postponed pensioning reduces incentives for individuals to start their pension early, therefore raises the proportion of older individuals who choose to remain non-pensioners.

In addition to these effects of actuarial fairness, the new system imposed tighter early pension pre-conditions, which should increase the proportion of older individuals who are required to postpone pensioning. These pre-conditions should become more binding over time, as the actuarially fair conversion of retirement savings into annuities diminishes monthly payouts due to a longer expected lifetime. The pre-conditions become irrelevant after 65, when everyone is eligible to start their pension, so only the incentive effect is left at that point. Non-pensioners are more likely to work than pensioners, because they face liquidity constraints. Thus, pension postponement further increases aggregate labor force participation rates.

To carry out this analysis we draw on 47 years of household surveys conducted by the Universidad de Chile, which give us employment and retirement data for members of 50 cohorts before and after the reform. We use a probit model with year of birth as a proxy for probability of membership in the new system. We focus on males age 50-70. Our main findings: Age-specific labor force participation rates (LFP) rose steadily among “post-reform” cohorts that reached old age after 1981, in contrast to the declining LFP observed before. The increase was particularly dramatic among pensioners, whose work propensities more than doubled—consistent with hypothesis #1. Initially pensioners worked much less than non-pensioners, but the gap has narrowed over the last two decades. We also observe a smaller increase in LFP among non-pensioners, especially those over age 65—consistent with hypothesis #2. At the same time, the probability of early pensioning fell steadily, further increasing aggregate participation rates. Postponed pensioning could be due to voluntary choice under actuarial fairness or to tighter pre-conditions on early pensions. The sharp drop-off in postponement at age 65 suggests that tighter pre-conditions dominate. These behavioral impacts of the reform remain after controlling for many individual and time-specific co-variates. Thus, both incentives and constraints play a role. The work incentive stemming from exempting pensioners from the pension payroll tax seems most important.

Part I reviews the literature on the impact of social security system rules on retirement age and develops our hypotheses about work and pension incentives in the new versus old Chilean schemes. Part II describes our data set, probit model, reform indicators and other variables. Parts III and IV estimate the impact of the reform on the probability of becoming a pensioner and of dropping out of the labor force for older men. The Conclusion highlights lessons for other countries.

I. What do Theory and Empirical Evidence Suggest about Retirement Choice?

Retirement behavior and pension systems: theoretical framework

An adaptation of the options value method of measuring marginal retirement incentives used by Gruber and Wise (2004) is the starting point for our analysis of the impact of the Chilean reform. According to this model, workers calculate the expected present value (EPV) of incomes for all future potential retirement dates. They postpone retirement beyond the earliest eligible age (t) to some future date (r), if the utility from the incremental EPV of net wages between t and r plus incremental lifetime benefit growth from t to r exceeds the utility from incremental leisure between t and r .

$$U[EPV\sum(W-C)^{tr} + EPV\sum(B(r)-B(t))] > U(L^{tr}) \quad (1)$$

where: $EPV\sum(W-C)^{tr}$ = exp. net wages (gross wages-contributions) between t and r

$EPV\sum(B(r)-B(t))$ = exp. added benefits from postponing retirement from t to r

$U(L^{tr})$ = discounted utility of incremental leisure between t and r

For many individuals, their social security wealth ($EPV\sum B$) in mandatory systems exceeds the amount they would have saved voluntarily. This increases the relative value they place on leisure, hence their desire to stop work earlier than they would have otherwise. However, work rarely stops before the pension starts because of liquidity constraints. This wealth effect on leisure preference, combined with liquidity constraints, is one reason workers start the pension at the earliest eligible age and stop work at the same time.

Gruber and Wise focus on a different force--the incentive effect on retirement stemming from the absence of actuarial fairness. We distinguish between 3 different dimensions of actuarial fairness—fairness with regard to the return to incremental contributions, the reward for postponing start of pension and the adjustment for ending the pension later (because of longevity growth). When mortality rates are given, in an

actuarially fair system 1) incremental contributions yield added monthly benefits with an EPV equivalent to the contributions and 2) postponing the pension age raises monthly benefits enough to hold the total EPV constant (see Disney, Queisser and Whitehouse 2006). That is,

$$EPV[\sum(B(r)-B(t))-\sum C^t] = 0 \quad (2)$$

Then, equation (1) collapses into equation (3), and work continues so long as:

$$U[EPV\sum(W)^t] > U(L^t) \quad (3)$$

In contrast, in an actuarially unfair system equation (2) does not hold. Gruber and Wise (1999 and 2004) show that DB systems are often actuarially unfair. Specifically, $EPV[\sum(B(r)-B(t))-\sum C^t] < 0$, creating a tax wedge between gross and net remuneration, leading the pension to start and work to stop in accordance with equation (1), sooner than it would under equation (3). Work is often restricted once the pension starts. As a result of these system rules, two potentially separable decisions--starting the pension and stopping work— are de facto linked, a single term—retirement--is commonly used to denote them, and workers retire at the earliest eligible age. As government policies have reduced the earliest eligible pension age, increased the tax wedge and expanded pension wealth, retirement age has dropped in many countries.

When evaluating systems over long periods of time, labor force participation rates can evolve via another path--the response to longevity growth. In systems that are actuarially fair with respect to longevity, the expected present value of lifetime contributions from start of work (s) to final contributions (F) equals the expected present value of lifetime benefits from pension age (p) to expected age of death (D)--for any pension age and final contribution date that might be chosen, as mortality rates change.²

$$EPV\sum C^{sF} = EPV\sum B^{pD} \quad (4)$$

Since the EPV of lifetime benefits is determined by the level of accumulated contributions, the monthly benefit must fall as life expectancy rises, in systems with lifetime actuarial fairness. This increases the marginal utility of retirement income relative to leisure. Individuals are likely to respond by voluntarily saving more and working longer, to restore their monthly benefits. If early pension eligibility is conditioned on benefit size, the constraint becomes more binding and postponed pensioning may be required.

In contrast, in actuarially unfair DB systems the equality in equation (4) does not hold and monthly pensions do not automatically fall when longevity increases. Instead, the EPV of lifetime benefits rises at the same rate as retirement time, leaving the relative utility of incremental income and leisure unchanged. Workers get the unchanged monthly benefit with no need to trade off current consumption or leisure, therefore no change in retirement age.³ Chile fit this picture before 1981.

Retirement rule changes in the Chilean reform and how they affect behavior

The Chilean pension reform was a complex package, with many rule changes. Starting with a system that was decidedly unfair actuarially, that tied the work and pension decisions together and made early retirement easy, the reform moved toward actuarial fairness in all dimensions, eliminated pension payroll tax and work restrictions for pensioners and tightened early retirement pre-conditions. The new system was basically a mandatory saving scheme with constraints on pension age and amount.

Moving toward actuarial fairness by replacing DB with DC. The old Chilean system consisted of several sub-systems, with different details but similar general outlines. In the largest sub-system, Servicio Seguro Social (SSS), the payroll tax for pensions was 23%, with another 10% for other social insurance, bringing the total to 33%.⁴ The monthly defined benefit was 50% of the base wage for the first ten years of

service but only 1% additional for each year thereafter, until a 70% ceiling was reached, at which point the incremental benefit became 0. While some groups received positive cross-subsidies as a result of this formula, for our purposes the important point is that increasing contributions or postponing the pension did not increase the benefit commensurately nor did greater life expectancy decrease it. As in many other countries with traditional systems, workers had an incentive to start the pension and stop work as soon as they became eligible, and rising longevity did not lead them to postpone pensioning or work longer.

In the new system, each worker is required to contribute 10% of his or her wages to an individual DC account, plus another 2-2.5% for administrative fees and disability and survivors insurance, totaling about half the old rate.⁵ Contributions are invested in a pension fund (AFP) of the worker's choice and accumulate a market rate of return. Payouts must take the form of price-indexed annuities or gradual withdrawals over the person's lifetime. Most retirees purchase annuities, delayed annuitization increases the monthly pension by an equivalent amount, and annuities have had a money's worth ratio of 100% or more, discounted at the risk-free market rate of return (James, Martinez and Iglesias 2006). Thus, the new system is actuarially fair at the margin, in the sense that incremental contributions and postponed pensioning are rewarded with equivalent expected real benefits. And it is actuarially fair over the lifetime in the sense that the EPV of lifetime benefits equals the EPV of lifetime contributions; monthly benefits are depressed as longevity increases. This increase in actuarial fairness might lead individuals to postpone pension age, hence to remain non-pensioners longer, and non-pensioners to work and contribute longer, on a voluntary basis.

At the same time, the incentive toward postponed pensioning and longer work may be limited by the fact that many individuals may not regard the new system as

completely fair, because their own subjective discount rates for time or risk do not coincide with market rates. For example: a worker may be forced to save at a higher rate than he would prefer; he wishes to start his pension sooner than the retirement age rules permit; he wishes to use his saving to cover emergency or other consumption in the early years of retirement; he prefers to invest in different ways from those permitted by regulations;⁶ or he may be in ill-health, hence does not expect to get back his full premium through annuities or gradual withdrawals. These negative effects were mitigated during the first 20 years of the new system by a high average annual real rate of return that averaged over 10%. They should be relatively small for workers with voluntary savings, who could offset any mandated saving to stay within their preferred gross saving rate. Ideally, we would examine the behavioral response of workers with and without voluntary saving, but our data do not give us information about individual-level saving. We do know that aggregate household saving increased during the post-reform period, but voluntary saving was negative every year (ranging between -2 to -8% of GDP)—suggesting that the mandatory rate exceeded the preferred rate for most people (Bennett, Schmidt-Hebbel and Soto 1999).

In general, restrictions on saving rate, investment choices and payouts in mandatory defined contribution social security systems, combined with heterogeneous savings-consumption and risk-return preferences among workers, create a tax wedge even in systems that are supposedly actuarially fair. It has been estimated that, on average, a 50% implicit pension tax remains in Chile.⁷ This would reduce the expected positive incentive effect of actuarial fairness on pension age and on work by non-pensioners. Since these restrictions were relaxed for pensioners and for non-pensioners over age 65, we analyze their effect by comparing pension postponement and work behavior by pensioners versus non-pensioners before versus after age 65.

Eliminating work restrictions and payroll tax for pensioners and for non-pensioners over 65. In the old system, continued work in the public sector was not allowed once the worker started the pension. Private sector work was allowed, but often workers had to change jobs upon pensioning. Moreover, contributions had to continue so long as the individual worked, even if he had already pensioned and got little or no additional benefit. In contrast, in the new system pensioners can continue working, with no restrictions. They are totally exempt from the pension payroll tax after pensioning. Any contributions after that point are purely voluntary. Their nominal net wage rises by 14% (12.5/87.5) after pensioning (or by 7% if the implicit tax component was 50%). Non-pensioners are also exempt after the normal retirement age of 65 for men (60 for women). This exemption for pensioners and for non-pensioners over 65 is expected to strongly increase their work incentive. In effect, this makes the system fully actuarially fair with respect to their continued work and incremental contributions.

Raising the allowable retirement age. In the old system, normal pension age was 65 for men, 55-60 for women, but earlier retirement based on length of service, disability or for other reasons was common.⁸ In the new system, normal pension age is 65 for men, 60 for women, and early pensioning was not permitted before 1988. Starting in 1988 it was allowed, but subject to tight restrictions. Until 2004 the retirement accumulation had to provide a benefit that was at least 50% of the worker's own average wage and 110% of the minimum pension guarantee (MPG), for pensioning prior to 65/60. Recently these were raised to 70% and 150%, respectively (Edwards and James 2006; James, Martinez and Iglesias, 2006). These constraints on early pensioning are likely to become more binding over time as longevity growth exerts a downward pressure on replacement rates.⁹

How these rule changes are expected to change behavior

In the new system we must distinguish between two dimensions of retirement: starting the pension and stopping work. We expect to find the following effects on participation rates and pension age of older workers:

1. *LFP—Tax-exemption of pensioners.* The removal of restrictions on their right to work and their exemption from the pension payroll tax should increase the age-specific work propensity for pensioners (and for non-pensioners over 65). For pensioners, the new system achieves complete actuarial fairness. Equation (3) applies in these cases.

2. *LFP—actuarial fairness for non-pensioners.* Actuarial fairness in a DC scheme may lead non-pensioners under age 65 to work longer, on a voluntary basis, because the implicit tax wedge has decreased so their net wage has increased. That is, we may observe a behavioral shift from equation (1) to equation (3) for non-pensioners. However, this impact may be smaller than that for pensioners, because the system remains incompletely fair to many workers and because the LFP of non-pensioners is high to begin with. The work response to the reform might be larger for non-pensioners over 65, at which point they become completely exempt from the pension payroll tax.

3. *Postponed pensioning--voluntary vs. involuntary.* Actuarial fairness might lead individuals voluntarily to delay pensioning beyond the earliest eligible age, because they will get a return from postponement. But if a tax wedge (albeit smaller) continues to exist, many individuals will prefer to start their pension as soon as possible, as they did before.¹⁰ However, tighter early retirement pre-conditions may lead to involuntary postponed pensioning, even for those who want to start early. These pre-conditions do not apply after age 65. Thus, the pension postponement effect should be larger for those under 65 and any postponement after 65 must be voluntary, due to actuarial fairness.

4. *LFP impact of pension postponement.* Since non-pensioners have higher participation rates than pensioners due to liquidity constraints, the rise in proportion of non-pensioners will further increase aggregate labor force participation rates.¹¹

5. *Longevity growth—impact on LFP and pension age.* When we examine changes over time, we must also take account of falling replacement rates due to longevity growth in a context of lifetime actuarial fairness (equation 4). This makes it harder for workers to satisfy the early pension requirements, raises the relative marginal value of income and should lead individuals to postpone labor force exit on a voluntary or involuntary basis.

Previous empirical studies on the U.S. and other countries

During the past decade a large empirical literature has developed to investigate the falling labor force participation rate among older men and the impact of pension system wealth and rules. The benchmark studies by Gruber, Wise and their colleagues (1999 and 2004) measure retirement incentives facing older men across eleven industrialized countries and through time. They show large work disincentives stemming from defined benefit social security systems, and the greater these disincentives the less likely individuals are to postpone retirement. Borsch-Supan (1998) finds similar effects for Germany and other European countries. A recent study by Lluberas (2007) finds that workers in DC plans expect to retire later than those in DB plans. Butler, Huguenin and Teppa (2004) attribute the falling labor supply of older men in Switzerland to the maturing of generous mandatory pension plans, which increased their pension wealth. Workers spend this wealth on longer periods of retirement leisure.

Several studies use U.S. data to examine the impact of social security wealth, implicit tax incentives and early retirement rules. They find small to modest effects that vary by income and marital status, and a discontinuous drop in labor force participation at

the earliest and normal age of eligibility for pensioning (Hurd 1990, Fields and Mitchell 1984, Burtless and Moffitt 1986, Stock and Wise 1990, Krueger and Pischke 1992, Blau 1994, Gustman and Steinmeyer 1985, Anderson, Gustman and Steinmeyer 1999, Coile and Gruber 2001). Song and Manchester (2006) find that the removal in 2000 of the retirement earnings test (which reduced benefits for pensioners who earned wages) increased work propensities substantially, especially among older individuals in the higher income percentiles. Friedberg (2007) summarizes various explanations for the recent trend toward delayed retirement (much smaller than that in Chile), including the elimination of the penalty for working while collecting social security benefits and the increased increment from delaying the start of benefits. Pang, Warshawsky and Weitzer (2008) find that increases in pension and other wealth raise the probability of retiring while the shift from employer-sponsored DB to DC plans delays retirement.

Most of these studies have had the advantage of longitudinal data, which we do not have. But the incentives they studied have not changed as dramatically as they did in Chile nor do they have such a long period of reaction time to observe the consequences.

II. Data, Probit Model and Reform Indicators

To carry out this analysis, we draw on 47 years of annual household surveys, the *Greater Santiago Area Encuesta de Ocupación*, covering 2500-3000 households in the greater Santiago area, collected by the University of Chile since 1957, with the latest available data from 2004. For all members of the household, we know their gender, schooling, marital status and number children, as well as their current wage, pension and other income. This is not a longitudinal or retrospective data set. Different individuals were observed in each survey. Our basic strategy is to construct the life employment and retirement histories of synthetic cohort members from data in the 47 surveys, assuming that the behavior of a given cohort, observed at different ages in successive cross-

sections, proxies a panel, if we control for individual and time-specific characteristics. Our analysis focuses on the 31,547 men in 50 cohorts born between 1900 and 1950 and observed at ages 50 to 70 at some point between 1960 and 2004. The first 21 years observed were pre- and the second 24 years post-reform. We link these data to variables that measure macroeconomic conditions for each year of the survey.

This data set, however, has several shortcomings. First, we are unable to separate those eligible for pension benefits from those ineligible. We know that social security coverage is incomplete because only 70-75% of men in the 70-74 age range collect pensions.¹² Since individuals who don't belong to any system or have only marginal affiliation are unlikely to be affected by the reform, our inability to remove them from the data set leads to an underestimate of the impact of the reform among those who do belong. This understatement applies particularly to non-pensioners.

We also do not know explicitly whether covered individuals are in the new versus old system. Our basic strategy is to use birth cohort as a proxy for probability of new system membership, and to analyze the change in work propensities among successive cohorts, who have increasing probabilities of new-system affiliation (Tables 1 and 2).

The 1981 reform placed new entrants to the labor force in the new system and gave existing workers the option to stay in the old system or switch. The propensity to switch to the new system was inversely correlated with birth age. By 1985 77% of all contributing workers were in the new system, including most workers under age 50, while the majority of older members were in the old system (Palacios and Whitehouse 1998; Acuna and Iglesias 2001; SAFP 2003; see Table 1). Among those born 1926-31, 40% of contributors were in the new system. Starting with birth-year 1931, more than half of each cohort ended up in the new system. Therefore, we define cohorts born before 1926 as “pre-reform” and those born after 1931 as “post-reform,” with 1926-30 as the

“bridge” generation, with a small expected reform effect in their later years. We expect the probability of new-system affiliation and new-system effects to rise with each successive cohort. We are modeling a transition from one system’s steady state to another, looking for sequential differences in the behavior of younger cohorts until the probability of new-system membership approaches 100%. At this point, a new equilibrium will be reached.

We focus on behavior between ages 50 and 70. Individuals under age 50 are unlikely to pension and withdraw from the labor force. If they do so, the pensions are probably disability pensions which have different behavioral models from old age pensions—but our data do not distinguish among benefit types. We stop at age 70 because we have few observations over 70 from new-system cohorts. We do not know the age at which individuals started their pension or initially withdrew from the labor force; we only know their present status. We also don’t know their voluntary saving. We confine the analysis to men, because many women receive survivors’ or social assistance pensions, which face different incentive structures from old age pensions. Also, women are more likely to be subject to the minimum pension guarantee, which increases the incentive to work until they qualify and decreases it thereafter—but we do not have information about their eligibility.¹³ We examine changes over time, for which the University of Chile data are ideally suited because they have been collected in similar form for half a century.

Summary of aggregate data

As a first descriptive step, we look at the aggregate data without controlling for individual or macroeconomic effects. Figures 1-5 summarize the aggregate picture.

(1) *Labor force participation by age and cohort.* In prime age, all cohorts have very high labor force participation rates--exceeding 95%--that remain high after the

pension reform. Participation rates fall after age 50 for all cohorts. But they fall much more slowly after the reform, for each successive post-reform cohort (Figure 1).

(2) *Aggregate participation by age over time.* Consequently, aggregate labor force participation of older men gradually rises through time after the reform, contrasting with the decline before. This effect is absent for prime-age men (Figure 2).

(3) *Participation rates of pensioners versus non-pensioners.* Participation rates are much lower among pensioners than non-pensioners. However, the increase after 1981 is concentrated in pensioners, so the gap in work propensities of these two groups narrows over time (Figure 3). (For example, among pensioners age 55 to 59, participation rates trebled between 1982 and 2004, from 14% to 42%, while work propensities among non-pensioners were fairly stable, at 90-94%).

(4) *Participation rates of pensioners versus non-pensioners for pre- versus post-reform cohorts.* For similar reasons, age-specific participation rates are higher for post-reform than pre-reform cohorts, especially among pensioners (Figure 4).

(5) *Pension probabilities by age over time.* The probability of being a pensioner before age 65 falls dramatically after the reform. Pension probabilities for individuals age 50-64 were at a 40-year low in 1997-2004—ranging from 10% in their early 50's to 30% in their early 60's--while pension probabilities over age 65 were close to their historic highs—over 60%--evidence of postponement, rather than reduced coverage (Figure 5).

Thus, prior to 1981 participation rates of older men were declining but starting in 1981 they have been rising. This effect is concentrated in pensioners. We do not observe it in non-pensioners or in prime-age workers. At the same time, the probability of becoming a pensioner before age 65 declined. This paper analyzes the connection between the 1981 pension reform and these empirical observations.

Probit model of retirement and pension probabilities

LFP. We use probit analysis to estimate retirement probabilities for older individuals. Our main dependent variable is the individual's labor force participation rate (*LFP_i*), which we model as a function of cohort-specific reform indicators (*R_c*), controlling for time-specific macro-economic characteristics (*E_t*), personal and family characteristics (*X_i*), pension status (*P_i*) and benefit size (*B_i*)—variables that influence the person's potential wage and willingness to trade-off wage for leisure.

Reform indicators are the main variables in our empirical analysis. Since we do not explicitly know the individual's system affiliation, our basic strategy is to proxy this probability according to his birth cohort. Earlier cohorts arrive at the age range we are examining before the reform, while later cohorts have an increasing probability of being in the new system. The age composition of our sample varies by cohort and the cohort mix varies by age (Appendix Table A1 and A2). We therefore expect different age groups to be at different points along the transition path, and their total reform effects by 2004 will vary. Moreover, we do not expect uniform reform effects for all cohorts at a given age, since later cohorts will have had more time to adapt in their life cycle planning. For these reasons, we measure discrete shifts for cohort groups, and these shifts are allowed to vary by age-range.¹⁴

To capture the effect of reform on the behavioral relationship described above, we construct a set of dummies that identify each individual observation according to one of seven birth-cohorts *Coh_k* and one of three age-groups (*G_j*). To compare reform effects on pensioners and non-pensioners, we interact the (*Coh_{ki}*)(*G_{ji}*) and *P_i* terms. In our reduced form probit model:

$$Pr(LFP_i=1 | R_{ci}, G_{ji}, P_i, B_i, E_{ti}, X_i) = \Phi(\sum Coh_{ki}G_{ji}\delta_{kj} + \sum Coh_{ki}G_{ji}P_{ki}\lambda_{kj} + P_iB_i\omega + E_{ti}\gamma + X_i\beta + \varepsilon_i) \quad (5)$$

where Φ is the standard cumulative normal probability distribution and the expression in parenthesis is the probit score for the LFP probit model. The model estimates a set of parameters that measure the effect of covariates on the probit score, and thus on the probability of LFP. We are particularly interested in the set δ_{kj} and λ_{kj} , which measure the effect of the pension reform.

Pension probabilities. As a subsidiary point, to see whether pensioning has been postponed by the reform, we also estimate the probability of being a pensioner:

$$Pr(PEN_i=1 | R_{ci}, G_{ji}, E_{ti}, X_i) = \Phi(\sum Coh_{ki} G_{ji} \tau_{kj} + E_{ti} \pi + X_i \alpha + \varepsilon_i) \quad (6)$$

where $\sum Coh_{ki} G_{ji} \tau_{kj} + E_{ti} \pi + X_i \alpha$ is the probit score for the PEN model.

There is a basic difference between the LFP and PEN equations. The Pen equation describes an on-going status. Once a person pensions, he or she stays pensioned; it is a once-and-for-all decision. Our data do not tell us when this decision was made or the characteristics of the worker at that point; they only tell us current pension status and characteristics. For reasons given above, we expect that in the new system, as in the old, many individuals will start the pension as soon as possible, but we cannot model that decision based on these data. Current pension status is mainly determined by past decisions or constraints and the PEN equation simply informs us of the current characteristics that are correlated with this status.

In contrast, the LFP decision is remade each month or year. Being out of the labor force in period 1 increases the likelihood of being out in period 2, and this likelihood and inter-period correlation increase with age, but nevertheless, individuals move in and out of spells of employment and non-employment until age 65 and beyond. (Meghir and Whitehouse 1997). Consequently, the LFP equation on which this paper focuses models current LFP decisions. Current pension status and amount are pre-determined variables.

Simulating reform effects for different sub-groups. We are particularly interested in measuring differences in reform effects across sub-groups, that is, in the interaction between the cohort, age and pension status characteristics of the individuals observed. Non-linearities make it inappropriate to use dprobits for this purpose. Therefore, we interpret our results using simulation of representative people in each sub-group (see Allison 1999; Berry, Esarey and Rubin 2007; Norton, Wang and Ai 2004; Tomz, Wittenberg and King 2003). We first estimate our probit models and use these coefficients to simulate the pension and labor force participation probabilities for individuals in different cohort-age-pension status groups, using a STATA routine.¹⁵ We report coefficients for a complete set of variables in the estimated probit equations in the Appendix and the simulated reform effects—our focus—in the text.

Reform indicators—cohort-age groups ($Coh_{ki}G_{ji}$)

Specifically: we collapse the 50 separate cohort birth years into seven broad cohort groups and represent each group by a dummy variable: (Coh_0 to Coh_6). Variations by age are captured by 3 age groups: 50-59, 60-64, 65-70. Table 2 defines each age-cohort group and their likely reform impacts.

Coh_0 , born 1900-1915 is the omitted control group. Coh_1 , born 1916-25, is the pre-reform cohort that was mainly affected by the old system. Coh_2 , born 1926-30, is the bridge generation, which was exclusively in the old system at age 50 but had a noticeable minority of new system members by age 60; we expect a small reform effect in their 60's. The next two cohort groups (Coh_3 and Coh_4), born 1931-35 and 1936-40, were closely divided between the two systems and should exhibit a significant reform effect, starting in their 50's and growing stronger with age as they learn and adapt. The final two cohort groups, (Coh_5 and Coh_6), born 1941-44 and 1946-50, were mainly in the new system so should display stronger and younger reform effects—but we observe them

mainly in their 50's. Since our data end in 2004, we are able to estimate Coh_0 to Coh_6 for the 50-59 age group, Coh_0 to Coh_5 for the 60-64 age group, and Coh_0 to Coh_4 for the 65-70 group. When a new equilibrium is reached, with full new-system membership, marginal effects will cease for successive cohorts, but the cumulative effect will remain.

Pension status and benefits (P_i and B_i)

Pension status. For reasons given above, we expect that pensioners will have 1) a lower LFP rate but 2) a more positive reform effect on LFP than non-pensioners. In some LFP specifications we interact $Coh_{it}G_{jt}$ with pension status, and we also run separate regressions for pensioners and non-pensioners. The estimated reform impact in pooled specifications with no pension controls combine two effects: the increasing proportion of non-pensioners, who have relatively high participation rates; and the rising participation rates of pensioners in post-reform cohorts. The specifications with pension controls and the separate regressions capture only the latter effect.

Benefit amounts. Rising benefits and social security wealth have been given as one explanation for falling participation rates of older workers during the 1970's and 1980's in the U.S. and Switzerland. In Chile, real pension amounts received by individuals plummeted during the early 1970's due to hyper-inflation without indexation, but they recovered steadily from the late 1970's on, in part due to wage growth. As a result, inflation-adjusted pensions of post-reform cohorts are higher than those of pre-reform cohorts. We use the actual benefit amount for each individual (pre-determined when the person pensioned) in our pensioner LFP equations and we expect a positive coefficient. This would have decreased pensioner LFP during the 1980's and 1990's in Chile--leaving a larger explanatory gap for the rising participation rates observed.

Wage replacement rates. But wages increased even more rapidly than pensions, therefore replacement rates moved downward. This was due to many factors, including

longevity improvement combined with actuarially fair conversion to annuities. Then, if individuals want to smooth their consumption, they might choose to save more and work longer. Additionally, falling potential replacement rates may mean that some individuals do not meet the threshold for early pensioning, must remain as non-pensioners, and continue working because of liquidity constraints. Our sample does not include data on prior wages of individuals, so we could not include the individual's own replacement rate as a variable. However, we created a pseudo-replacement rate for pensioners by taking the ratio of individual i 's pension to mean wage for i 's cohort and schooling group in the age range 40-49 (as a proxy for i 's own wage). For reasons given above, we expect a negative coefficient, so the fall in pseudo replacement rates after the reform may help explain the observed increase in participation rates.

Macro-economic and individuals characteristics (E_{it} and X_i)

Many other changes were taking place in the Chilean economy and society over the period studied, including severe macro-economic cycles, labor market development and dramatic increases in education and wages. To throw additional light on the retirement decision and to make sure we are not confusing the reform effect with other changes that were occurring over the period studied, we control for a number of time-specific macro-economic variables and individual characteristics whose average values changed over time. These include unemployment rate, deviations from Hodrick-Prescott filter (which measures cyclical variations), individual's education level, household income per capita, marital status, labor market status of wife, spousal age differential and children. All the probits on which our simulations are based include these macro-economic and individual co-variates. (See Table 3 for definition and means of covariates, development of hypotheses about co-variates in Appendix and Tables A3-5 for underlying probits).

III. Reform on Pension Probabilities

Pension postponement for successive cohorts

Table 4 presents our simulations of marginal changes in pension probabilities by cohort and age group, and the cumulative post-reform effect. As expected, we find that post-reform cohorts postpone pensioning. Indeed, starting with Coh₃ the probability of being a pensioner declines by 2 to 6 percentage points per successive cohort-group, for ages 50-64 (Table 4). By Coh₆, the last cohort observed in age group 50-59, the cumulative post-reform reduction in pension probabilities totals 10 percentage points. By the last cohort observed in ages 60-64, it totals 8.1 percentage points—but for this age range we don't yet have full data for Coh₅ and Coh₆. These reductions are large, compared with the respective estimated pre-reform (Coh₁) pension probabilities of 21% and 37% for these respective age groups.

Incentives vs. constraints: significant but smaller changes after age 65

Postponed pensioning could be caused by tighter early retirement constraints or by voluntary choice under greater actuarial fairness, which made workers more willing to save through the pension system. We cannot directly separate these two sources for individuals under age 65. However, since everyone is eligible to start their pension by age 65, we expect to find a smaller reform impact after 65 and any further decline would be attributable to incentives, not constraints. In fact, for ages 65-70, our estimations show no significant marginal or cumulative reductions in pension probabilities for post-reform cohorts. This suggests that tighter constraints on early retirement are probably the dominant reason for postponed pensioning.

However, we may be underestimating the impact of actuarial fairness on pension age, for several reasons: First, many individuals who were not pensioned by age 65 are probably not in any pension system and therefore are not subject to its incentives and

constraints. If these non-affiliates were excluded from the sample, we might find a larger change in behavior for those who remained—the system members. Second, for the over-65 age group we do not yet have evidence from COH₅ and ₆. Additionally, older people are likely to have a stronger preference to dissave and consume even in an actuarially fair system, because their remaining lifetime is scarcer and their accumulated savings are larger. Thus, even if postponement stopped at age 65, this does not mean that actuarial fairness played no role for those under 65.

Also, actuarial fairness with respect to longevity has probably made the early pension constraint more binding over time. According to Chilean mortality tables constructed in 1985 and 2004, life expectancy for males in their 60's increased by 2 years over this period. Our annuity calculations indicate that this would have decreased replacement rates by 5% in an actuarially fair system. Eligibility for early retirement depends on replacement rates. By 2004, *ceteris paribus*, men close to the early retirement threshold would have had to postpone pensioning by .8 of a year—over half the average postponement—to make up this amount and pass the threshold.¹⁶ Raising the pension age automatically in response to longevity growth by actuarially fair conversions of retirement savings into annuities may be one of the most important features of the reform.

Other co-variates

Could the decreased pension probabilities be caused, in part, by changing macro-economic or demographic conditions? A 1 percentage point increase in *unemployment rate* increases pension probabilities by .3 percentage points (derived from Table A3). Thus, the 15 percentage point drop in unemployment rates during the mid-to-late 1980's might account for part of the decrease in pension probabilities—but the 8 percentage point rise during the late 1990's would be expected to have the opposite effect. Having 6 or less years of schooling or having many children have highly significant negative

coefficients, so the sharp decline in the values of these variables should have increased pensioning—but instead a decrease occurred. *Having a spouse who worked* also has a negative impact on pension probabilities; thus the growth in female labor force participation may have contributed to the observed pension postponement. These results are all consistent with our hypotheses (see Appendix). Nevertheless, the pseudo R^2 rises very little—from .119 for cohorts alone to .148 when all co-variates are added, and the negative impact of the reform on pension probabilities remains very strong.

IV. Reform Impact on Labor Force Participation (LFP) Rates

LFP rates in pooled sample, no pension controls—under and over age 65

The reform impact on LFP rates is even more striking, before and after age 65. Table 5 presents our simulations of reform effects on LFP rates in the pooled sample, without controlling for pension status. This captures all sources of increased participation—exemption of pensioners from the pension payroll tax, changing behaviors of non-pensioners due to actuarial fairness, and increased proportion of non-pensioners as early retirement rules tighten. (See Table A3 for underlying probit).

The negative coefficient on Coh_1 indicates that participation rates of older workers were declining in pre-reform years, as elsewhere in the world. But starting with Coh_2 in their late 60's, Coh_3 and Coh_4 in their 50's, this decline stops and we observe significant marginal increases in LFP of 2 to 7 percentage points per successive cohort group. The reform effect continues to grow for Coh_5 and Coh_6 , who are fully observed only in their 50's. Cumulative gains totaled 12-19 percentage points by the last observations in ages 50-64 and 13 percentage points for ages 65-70. Since marginal coefficients for the last cohort observed continue to be positive, a steady state may not yet have been reached and the totals may increase further.

The strong post-65 LFP effect contrasts with the weak post-65 effect on pension probabilities. Despite the likelihood that willingness to trade off leisure for income will diminish with age, workers apparently respond to system rules that are designed to raise work propensities for this age group—through the exemption of pensioners and of non-pensioners over 65 from the payroll tax.

Reform impact on participation rates of pensioners vs. non-pensioners

Table 6 controls for pension status and amount and differentiates cohort effects between pensioners and non-pensioners, using the full sample. Tables 7A and B present the reform effects on LFP, breaking down the sample between non-pensioners and pensioners. Both tables allow us to test whether the new system had different effects on these two groups, before or after age 65. Table 6 constrains other co-variates to be the same for both groups while Table 7 allows them to vary. The cohort effects turn out to be very similar in both specifications. Since pension status is given, neither table includes the impact of changing proportions of pensioners and non-pensioners. Therefore the weighted average of effects for pensioners and non-pensioners in Tables 6 and 7 should be less than the pooled effects in Table 5. (See Tables A4-5 for underlying probits).

It is most useful to look at the changing behavior of pensioners and non-pensioners before and after age 65. Prior to 65 we expect the reform impact to be stronger for pensioners, because of the complete elimination of the pension payroll tax and the removal of work restrictions, while any impact on non-pensioners would stem from the increased actuarial fairness of the system, which is incomplete and less transparent. After age 65 non-pensioners too are exempt from the pension payroll tax. Consequently, they should behave more like pensioners at older ages.

Starting first with pensioners: their participation rates rise substantially, by 5-16 percentage points for each successive cohort, in each age range. This process starts with

Coh₂ in their late 60's, Coh₃ in their early 60's and Coh₄ in their 50's, as later cohorts had an opportunity to affiliate with and adapt to the new system at earlier ages. For ages 50-64, cumulative gains in LFP rates of post-reform pensioners totaled 28-34 percentage points—more than doubling their pre-reform work propensities. Since marginal gains are still large for Coh₅ and Coh₆, a new steady state has probably not yet been reached and the total increase may eventually be greater. By comparison, participation rates were falling strongly for pre-reform Coh₁. A turn-around in participation rates of pensioners obviously occurred after the reform.

Work propensities also rise, but by a smaller amount--15-17 percentage points--for pensioners over age 65. The smaller increase may be due to the stronger preference for leisure time among older individuals, or to the fact that Coh₅ and Coh₆ haven't yet reached these ages. In contrast, the marginal impact of the reform on the LFP of non-pensioners shows up only after age 65. The cumulative post-reform impact on non-pensioners is only 1 percentage point in their 50's. It reaches 5 percentage points in their early 60's and 11-12 percentage points after 65.

Thus, the evidence points toward a much stronger reform impact on pensioners than non-pensioners, and a larger impact on non-pensioners after age 65 than before. The total elimination of the pension payroll tax is easier to evaluate, while the partial increase in actuarial fairness for non-pensioners is smaller and more difficult to figure out. Moreover, non-pensioners are already working at very high rates so there is not much space for further increases. The 5 percentage point increase in work propensities in their early 60's actually amounts to a 42% decrease in the probability that they will be out of the labor force. It is also likely that we have underestimated the reform impact on non-pensioners who are affiliated to the system, because these data do not separate them out from individuals who are not affiliated. On balance, this evidence supports the hypothesis

that partial actuarial fairness has a positive impact on work, but not as much as complete exemption from the payroll tax.

Direct impact of pensioner status and amount

We also examine the direct impact on LFP of pensioner status and benefit amount. We expect that pensioners are less likely to work than non-pensioners in both the old and new systems, because of access to pension wealth, hence fewer liquidity constraints. Thus pensioner status and amount should have a strong negative impact on LFP and should increase the explanatory power of the equation. Indeed, the pseudo R^2 jumps from 16% to 48% when pension and its interaction effects are introduced (Table A4 compared with A3). Before the reform (for Coh₁), becoming a pensioner in your 50's decreased participation by 66 percentage points. However, the pensioner-non-pensioner gap is almost cut in half points post-reform (Tables 6 and 7). We have already seen that postponed pensioning increases LFP rates by raising the proportion of non-pensioners; but this becomes somewhat less important in the new system, where pensioners are more likely to work.

To assess the impact of benefit size we used, alternatively, pension amount and pseudo replacement rate in our specifications; results were similar and we present the latter (Tables A4 and A5). As expected, the larger the pension amount, the lower is the work propensity, due to an income or liquid wealth effect. But if consumption-smoothing is the goal, the replacement rate is more relevant. A higher pseudo replacement rate reduces the LFP rate significantly—by 3 percentage points for every 1 percentage point increment in replacement rate. This is indirect evidence that, if replacement rates fall over time due to longevity growth in actuarially fair systems, the LFP of pensioners will rise.

Could the large reform effect on pensioners be due to selection bias?

Could the large response by pensioners be due to selection bias—a change in composition among pensioners toward those with higher work propensities and vice versa for non-pensioners? Under the old system, some individuals with a high propensity to work had to postpone pensioning in order to keep their job. The delinking of work and pension choices in the new system means that these individuals can now become pensioners and continue working. At the same time, the tightening of early retirement restrictions means that fewer people can satisfy the pre-conditions for pensioning prior to age 65. The new system conditions early access to pension on meeting a fund accumulation/replacement rate threshold, which is more likely to be achieved by those who contributed persistently—because they have higher work propensities. The old system granted early retirement status more liberally, and possibly to many with lower work propensities. All these effects could raise average participation rates among post-reform pensioners compared with pre-reform pensioners, due to selection bias into pensioner status of those with high work propensities.

However, our findings are not consistent with selection as the major explanation. If the shift of individuals with high work propensities into pensioner status were the main reason for the rising work proclivities of pensioners, it follows that labor force participation would have fallen for non-pensioners, it would not have continued increasing after age 65 when everyone can become a pensioner, and the reform would not have had a positive impact over-all, when pension status was not controlled. On the contrary, we find that non-pensioners remain more likely to work than pensioners and they work somewhat more than they did before the reform. Labor force participation also increased both for pensioners and non-pensioners over 65. Finally, the increase in post-reform LFP rates remains (in fact, is larger) when pension status is not controlled. This is

consistent with the view that we are observing behavioral change due to new incentives and constraints, rather than simply a rearrangement of people with unchanged behaviors.

Does the reform effect hold with individual and macro-economic controls?

We include a long list of macro-economic and individual co-variates, whose average values change over time, in these models. In Tables A3 and A4 the co-variate coefficients are constrained to be the same for pensioners and non-pensioners. In Table A5 we run separate regressions for pensioners and non-pensioners, thereby allowing the coefficients to vary. In almost all cases, the coefficients of these co-variates are significant and consistent with our predictions in the Appendix; but they do not erase the reform impact.

We use *unemployment rate* and *deviations from H-P trend* to capture cyclical variations over time. Because of the high correlation between these two variables we use them as alternatives rather than including them both in the same equation. *Unemployment rate* has a significant negative effect (-.27 percentage points of LFP for every 1 percentage point of unemployment) when pension status is not controlled, which becomes insignificant and less negative (-.09 percentage points) when pension is in the equation. This implies that the negative unemployment impact on work propensities is largely due to its positive impact on pension probabilities. *Deviations from H-P trend* (not shown) have a significant positive effect on LFP rates, meaning that work propensities increase during cyclical upswings. Neither of these variables had a monotonic impact on LFP rates over time, since both upswings and downswings occurred after the reform.

Post-secondary education has a significant positive effect on LFP rates. Apparently the positive substitution effect from higher pecuniary and non-pecuniary remuneration to those with post-secondary schooling outweighs the negative income

effect on participation. Jobs obtained by more educated people may entail less disutility, are less physically demanding and reward experience, hence are more likely to continue to be held at older ages. Thus, the shift toward higher education during the post-reform period would have increased participation rates. Having only *primary school education* has a negative effect on LFP rates when pension status is controlled, turning to positive when pension status is not controlled. This suggests that if workers with primary education qualify for an early pension the substitution effect and physical disutility of work lead them to stop sooner, but in fact they are less likely to qualify so must continue working longer. Thus, the shift away from primary education would have decreased participation rates, leaving a greater gap to be explained by the reform.

Having a higher household income increases the probability of pensioning, thereby reducing LFP in the pooled equation without pension controls. It also decreases participation rates of non-pensioners, perhaps because it relaxes liquidity constraints. Then, the increase in household income that occurred over this period would have reduced over-all LFP rates. Among pensioners this negative impact is absent, possibly because pension amount or pseudo replacement rate are more relevant income indicators.

As expected, *number of children under 18*, *presence of spouse* and *age differential between husband and wife* all have highly significant positive effects on the LFP of older males. Having a *working wife* increases LFP for pensioners (they continue their market work rather than shifting to home work) but decreases it for non-pensioners (perhaps because it reduces their liquidity constraints). Over-all these effects cancel out so there is no significant impact in the equations with pension controls. However, in the pooled equation without pension controls male LFP increase when the wife works. This positive effect may be due to the reduced probability that husbands will start their pensions early if their wives are still working.

In sum: The decline in unemployment, the higher education growth and rising female labor force participation rate that have taken place in the Chilean economy over the past two decades probably account for part of the observed rise in aggregate labor force participation rates of older male workers. But other co-variables had counteracting effects. Over-all, the pseudo R^2 in our probits change very little when the co-variables are added. In the pooled LFP equation it rises from .128 for cohorts alone to .157 in the pooled equation with co-variables. In contrast, the addition of pension controls and interactions in the full sample raises the pseudo R^2 to .478. Most important for this analysis, the reform effects on probability of pensioning and LFP rates of pensioners remain large and significant when the co-variables are in the equation.

Impact on total labor supply and benefits, and decomposition of these effects

Impact of higher LFP on labor supply, human capital, output and income. By the last cohort-group in our sample, COH₆, the total increase in labor force participation rate relative to pre-reform COH1 for ages 50-64 is estimated to be 13.8 percentage points.¹⁷ A 13.8 percentage point increase in annual LFP for 15 years between ages 50-64 would raise expected lifetime work by 2.1 years. Given their average pre-reform 73% participation rate, it represents a 21% increase in the labor force of this age group (or 4% of the labor force as a whole if this age group constitutes about 20% of the entire labor force). We don't yet know the full effects for those over age 65, but it appears that this group will add substantially to the total increase. This increase will also grow larger as the proportion of older workers in the population rises and a new steady state is reached for later cohorts. Additionally, since withdrawals for pensions are postponed, national saving rises, *ceteris paribus*. If the incremental capital holds constant the marginal productivity of labor, annual national output will rise by 4%.

While we could not quantify the impact on human capital, it seems likely that this will increase too, as older workers carry with them more experience. Furthermore, the expectation of longer working lives adds to the potential return to education and should lead middle-aged workers and their employers to invest more in on-the-job training. This could further increase national output in the long run.

In a PAYG DB system in which contributions are pooled, raising the LFP improves the system's finances by increasing revenues. Depending on the linkage between contributions and benefits, it may or may not raise pension amounts. In a DC system, in which each person has his or her own account and the contribution rate is fixed, these measures improve the monthly pension ultimately received by the individual. If part of the resulting income is saved in order to increase the standard of living while working and retired by the same proportion, this implies an annual increase of about 16% in annual standard of living from age 50 on.¹⁸ Further increases would accrue as work continues past age 65 and as the incentive to acquire human capital grows.

Impact of postponed pensioning on saving and monthly benefit. In addition to the decision to work longer is the decision to start the pension later. In age group 50-59, the probability of being a pensioner has fallen by 10 percentage points for COH₆ relative to pre-reform COH₁. The reduction is somewhat less at 60-64, but this figure will probably grow as later cohorts enter this age group. A 10 percentage point annual reduction in pension probability for 15 years implies, on average, a 1.5 year postponement in start of pension. Abstracting from the higher LFP (already taken into account above), postponing the start of pension constitutes a decision (or requirement) to consume the same present value of retirement savings over a shorter time period. This increases the average monthly benefit during the pension stage by about 14%.

Combined impact of higher LFP and postponed pension on benefits and leisure.

Combining these two effects, if the pension would have replaced 50% of the person's earnings without these changes, it replaces $50\% + .14 \cdot 50\% + .16 \cdot 50\% = 65\%$ of pre-reform earnings afterwards. To achieve this same increase in monthly benefits without changing participation rates or pension age would have required a 3 percentage point rise in the pension payroll tax.

The trade-off for higher benefits, of course, is less retirement leisure time and lower pension income in earlier years. To the degree that individuals have made these choices voluntarily based on removal of a distortionary tax wedge or an increase in expected longevity, the private gains are perceived to outweigh the costs. However, if these choices were based on a requirement to postpone pensioning, this implies a collective decision to override personal preferences, on grounds that they might be myopic and contrary to the individual's long term interests.

Decomposition of higher LFP: increased work propensities vs. postponed pensioning? To approximate how much of the total increase in LFP is due to increased work propensities of pensioners and how much to the increased proportion of non-pensioners, we compare the reform impact of the models with and without pension controls. For example, in age group 50-59 pooled LFP rose by 11.7 percentage points; this captures both forces on LFP. At the same time, the corresponding increase for pensioners alone was 28.3 percentage points and for non-pensioners 1.26 percentage points (Tables 7A and 7B). Since 19% of our pre-reform sample in this age group were pensioners, if this proportion had remained constant the total post-reform increase in participation rates would have been only $28.3 \cdot .19 + 1.2 \cdot .81 = 6.4$ percentage points. This tells us that $6.4/11.7 = 55\%$ of the total estimated pooled increase is mainly due to the payroll tax exemption and removal of work restrictions on pensioners. The remaining 5.3

percentage points, or 45% of the total, is attributable to pension postponement and the increasing proportion of non-pensioners that occurred post-reform—due to tighter early pension constraints plus actuarial fairness. A similar calculation shows that 71% of the total LFP increment at 60-64 and practically the entire increment at 65-70 were due to increased work propensities, mainly of pensioners. Thus, increased work by pensioners is the primary force for higher LFP among the old-old, but pension postponement also plays an important role among the young-old.

V. Conclusion

Many countries with aging populations are seeking ways to increase work propensities and delay pension probabilities of their older workers. Chile is an unusual case in that the labor force participation rates of its older workers have been increasing and pension probabilities decreasing for the past 25 years. This increases the labor supply, the stock of human capital that is embodied in older experienced workers, and the incentive to acquire more training that will be utilized for more years. We argue that Chile's unusual participation rate trend is mainly due to incentives and constraints stemming from its new social security system.

Pre-reform Chile looked like many European countries today—with early and declining age of pension and withdrawal from the labor force. These trends were sharply reversed and the labor supply of older workers, especially pensioners, began a sustained rise in 1981, while participation rates of prime age workers and non-pensioners under age 65 changed little if at all. The pension reform was the big event at that time that could have affected the labor supply of older more than prime-age workers, and of pensioners more than non-pensioners, especially under age 65.

The expected impact is very sensitive to details of the reform. We hypothesize that participation rates of older workers will increase due to:

1) Greater incentives for pensioners to continue working because the new system exempts them from the pension payroll tax and eliminates work restrictions that existed previously. These results should be strongest because tax exemption is very transparent and grants pensioners complete actuarial fairness.

2) Increased actuarial fairness for non-pensioners, which increases their net wage. The implicit tax for incremental contributions fell with the reform, although it was not eliminated. Therefore non-pensioners should work longer, although the effect should be weaker than that for pensioners. The reform effect for non-pensioners over 65 should be similar to those of pensioners, since they are also exempt from the pension payroll tax.

3) Actuarial fairness may lead individuals to postpone pension age, on a voluntary basis. Furthermore, tighter early pension pre-conditions constrain more individuals to remain non-pensioners. This constraint and its impact on pension age ends at 65. Early pension pre-conditions should become more binding over time as longevity growth dampens monthly benefits, if the payout stage is actuarially fair.

4) Whether postponed pensioning is voluntary or involuntary, it usually involves a decision to work longer because of liquidity constraints.

Repeated household surveys collected by the University of Chile for over half a century enable us to study long term trends in participation rates and how they changed after the pension reform, using the person's birth cohort as a proxy for the probability of new-system affiliation. In particular, we exploit the fact that different subgroups face different incentives and constraints that should lead to different behaviors. Our results underscore that the labor supply of older workers responds strongly to tax incentives. This is consistent with other recent work on older workers, and contrasts with the inelasticity of labor supply of younger workers found previously.¹⁹ We estimate a

cumulative increase of 11.7 percentage points in participation rates of cohorts that recently entered the 50-59 age range and 18.8 for ages 60-64, relative to pre-reform rates.

More than half of this is due to the exemption from the payroll tax for pensioners, whose participation rates climbs by 28-34 percentage points at ages 50-64 and 15-17 percentage points over age 65, relative to pre-reform rates. The LFP response of non-pensioners is also significant but much smaller—only 1.2 percentage points in their 50's, rising to 5-6 percentage points at 60 and 11-12 percentage points for those over 65—when non-pensioners also become exempt from the pension payroll tax. Actuarial fairness due to the DC scheme apparently has a much weaker effect than complete payroll tax exemption.

The remaining part of the over-all increase in LFP is due to postponed pensioning, which increases the proportion of older individuals who remain non-pensioners. The reform tightened the pre-conditions for early pensioning and pension probabilities prior to age 65 decreased by 10 percentage points. Pension postponement disappeared after age 65, when these pre-conditions no longer applied. This suggests that early pension constraints, reinforced by life time actuarial fairness, play a dominant role in determining the division of the elderly between pensioner and non-pensioner status. Although time-sensitive individual characteristics and macro-economic cycles have a significant impact on pension probabilities and LFP, they do not erase these reform effects.

This analysis raises several caveats and questions for future research. The results for non-pensioners who are in the system may be understated because they cannot be distinguished from those who are not in any formal system. Pensioning may not be postponed beyond age 65 despite new-system incentives because of a life-cycle effect--the preference for saving diminishes with age.²⁰ The system may be more actuarially fair to certain sub-groups, such as individuals who have their own voluntary saving that can

offset the mandated saving, than to others who are at a corner solution with no saving, because their discount rate exceeds the market's. Women pose still other problems, since they may be sensitive to incentives stemming from survivors' benefits, joint annuities and the minimum pension guarantee. In later work we plan to utilize a different data set that provides more individual-level information on system affiliation, type of pension and voluntary saving, to explore these differences among sub-groups. By contrast, the current data set provides us with a long time perspective for men and avoids issues of selection between systems and between the formal and informal sectors.

These results have important policy implications. Actuarial fairness for non-pensioners, by definition, implies a DC-type scheme.²¹ But the other policies that we have focused on could be adopted whether the underlying social security scheme is DB or DC. The response to Chile's new system suggests that labor supply can be increased substantially by 1) Raising the net reward that older individuals receive for working and making these rewards easy to perceive and measure, for example, by exempting workers from the pension payroll tax after a specified age or pension threshold; 2) Raising the earliest allowable age for pensioning; and/or 3) Tying pension age to life expectancy, either directly or indirectly via the actuarially fair conversion of accumulated contributions to benefits, while conditioning early pension age on benefit size or replacement rates.²²

Table 1: Percentage of contributors and pensioners in new system

cohort number	Cohorts born	%contributors in new system, 1985*	%contributors in new system, 2000**	%pensioners, age 50-70, in new system, 2002***	% male pensioners, age 50-70, in new system, 2002***
COH ₀	1916-25	28	NA	NA (>70)	NA (>70)
COH ₁	1926-30	40	NA	NA (>70)	NA (>70)
COH ₂	1931-35	48	68	38	45
COH ₃	1936-40	58	79	50	59
COH ₄	1941-45	72	85	66	67
COH ₅	1946-50	82	94	77	73

* Source: Calculations by authors based on Palacios and Whitehouse 1998. Because many old-system members in cohorts born 1916-25 had already started their pensions and dropped out of the labor force by 1985, these numbers overstate new-system affiliation among all individuals covered by social security in these cohorts.

** Source: EPS 2002. Because new system affiliates were less likely to be pensioners than old-system affiliates, and therefore more likely to contribute as workers, these numbers slightly overstate new-system affiliation among all individuals covered by social security in these cohorts. There were very few contributors in 2000 for COH1 or 2, because they were >70.

*** Source: EPS 2002. Because new system affiliates were less likely to become pensioners than old-system affiliates, these numbers understate new-system affiliation among all individuals covered by social security in these cohorts.

Table 2: Age of different cohorts at time of reform and end of our sample

Cohort number	Born in:	Age in 1981	Age in 2004	Expected impact on pension prob	Expected impact on pensioner lfpr	Last age observed in sample
COH ₀	1900-15	66-81	89-104	Control-old system	Control-old system	70
COH ₁	1916-25	56-65	79-88	Control-old system	Control-old system	70
COH ₂	1926-30	51-55	74-78	Negligible	Small, in 60's	70
COH ₃	1931-35	46-50	69-73	Moderate	Moderate, in 60s	70
COH ₄	1936-40	41-45	64-68	Large	Large	68
COH ₅	1941-45	36-40	59-63	Larger, but <65	Larger	63
COH ₆	1946-50	31-35	54-58	Larger, but <60	Larger, in 50s	58

Table 3: Variable Definitions and Sample Means (Men 50-70)

Variables to capture the age profile of participation and pension probabilities		
Age-50	Age minus 50	Varies between 0 and 20
Age-60	Age minus 60 if >60	Varies between 0 and 10
Age-64	Age minus 64 if age>64	Varies between 1 and 6
Variables to capture the effect of individual and pension characteristics (X_i and B_i)		
Ed6 or less	Dummy=1 if schooling<=6	0.40
Ed12 or more	Dummy =1 if schooling>=12	0.35
Real Hh income per capita	Real household monthly income per capita (minus own wage+pension) 1977 pesos	876
Benefit amount	Real monthly pension income in 1977 pesos (for pensioners)	3,350
Pseudo replacement rate	Pension Income for indiv i/ mean wage of 40-49 year olds in i's cohort and ed group (for pensioners)	0.74
#children	# of children younger than 18	0.59
Spouse present	Dummy=1 if the individual has a spouse living in hh	0.81
Spouse in LF	Dummy=1 if the individual's spouse works (if spouse present)	0.23
Spousal age diff	Own age-spouse age (if spouse present)	5.1
Variables to capture macroeconomic effects E_t		
UnE rate	Unemployment rate in %	10.5
Deviations from H-P trend	Real lnGDP growth rate minus Hodrick–Prescott filter in %	0.19
Variables to capture total change for COH_k relative to COH_0, within specified age group, in probits		
COH_0	Dummy=1 if born 1900-15	1 or 0
COH_1	Dummy=1 if born 1916-25	1 or 0
COH_2	Dummy=1 if born 1926-30	1 or 0
COH_3	Dummy=1 if born 1931-35	1 or 0
COH_4	Dummy=1 if born 1936-40	1 or 0
COH_5	Dummy=1 if born 1941-45	1 or 0
COH_6	Dummy=1 if born 1946-50	1 or 0
Total post-reform change	COH_k coefficient- COH_1 coefficient	
Marginal changes by successive cohorts	$Coh_k = COH_k$ coefficient- COH_{k-1} coefficient	
Variables to capture differential impact of reform on pensioners and non-pensioners		
$Pen*COH_k$	Dummy = 1 if in COH_k & pensioner, else 0	1 or 0

Table 4 : Reform effects as captured by the impact of successive cohorts on **pension rates** (calculations shown in percentage points)^a

	AGE GROUP		
	Age 50 - 59	Age 60 – 64	Age 65 – 70
	Average pension rates at start		
Estimated pension rates for COH₀	20.5*	34.91*	57.72**
	Marginal effects of successive cohorts ^b		
Coh₁	0.18	2.18	7.64*
Coh₂	-1.39	0.58	-0.53
Coh₃	-2.56**	-4.00***	-1.31
Coh₄	-3.82**	-6.63*	0.45
Coh₅	-0.89	1.92	
Coh₆	-1.38		
	Total post-reform effect		
Last COH observed relative to COH₁	-10.04**	-8.10**	-1.4

^a Simulated at the mean age of the corresponding age group, setting all other covariates at their mean. Results based on model reported in Table A3. (The marginal effects of other covariates can be approximated by dividing the pension rate coefficients reported in Table A3 by 3.1).

^b Marginal effects for Coh_k are the difference in total pension probability from COH_{k-1} to COH_k. They are estimated at the mean age of the corresponding age group, setting all other covariates at their sample mean.

* significant at 1%

** significant at 5%

***significant at 10%

Table 5: Reform effects as captured by the impact of successive cohorts on **labor force participation (LFP) rates**. Full sample, no pension controls (shown in percentage points)^a

	AGE GROUP		
	Age 50 - 59	Age 60 – 64	Age 65 – 70
	Average LFP rates at start		
Estimated LFP rates for COH₀	80.38*	62.89*	38.32*
	Marginal effects of successive cohorts ^b		
Coh₁	-1.40	-3.93**	-5.49*
Coh₂	0.73	1.73	5.83*
Coh₃	2.47**	7.31*	4.93***
Coh₄	4.46*	7.47*	2.09
Coh₅	2.27**	2.30	
Coh₆	1.80***		
	Total post-reform effect		
Last COH observed relative to COH₁	11.73*	18.81*	12.85**

^a See note a, Table 4. Results for Table 5 are based on model reported in TABLE A3. This model does not control for pension status. (The marginal effects of other covariates can be approximated by dividing the LFP coefficients reported in Table A3 by 3.12)

^b See note b, Table 4 for definition of marginal effects and significance levels.

Table 6 : Reform effects as captured by the impact of successive cohorts on **labor force participation (LFP) rates**. Full sample with pension controls and interactions. (Shown in percentage points)^a

	AGE GROUP		
	Age 50 - 59	Age 60 – 64	Age 65 – 70
NON-PENSIONERS			
	Average LFP rates at start—non-pensioners		
Estimated LFP rates of non-pensioners in COH ₀	94.63*	87.36*	74.33*
	Marginal effects of successive cohorts--non-pensioners ^b		
Coh ₁	0.31	0.16	-2.39
Coh ₂	-0.45	2.43	8.61*
Coh ₃	0.69	1.79	-2.30
Coh ₄	0.85	-0.03	4.25
Coh ₅	0.13	0.75	
Coh ₆	-0.22		
	Total post-reform effect--non-pensioners		
Last COH obs. relative to COH ₁	0.99	4.94	10.56**
PENSIONERS			
	Effect on LFP at start--pensioners		
Change in LFP due to pensioning, COH ₀	-66.44*	-68.30*	-61.63*
	Marginal effects of successive cohorts--pensioners ^b		
Coh ₁	-8.34*	-6.64**	0.23
Coh ₂	1.28	1.94	4.96**
Coh ₃	-0.38	10.78*	10.67*
Coh ₄	6.83**	11.17*	1.25
Coh ₅	16.65**	8.81	
Coh ₆	9.20***		
	Total post-reform effect--pensioners		
Last COH obs. relative to COH ₁	33.59**	32.71**	16.89*

^a See note a, Table 4. Results for Table 6 are based on model reported in TABLE A4. (The marginal effects of other covariates can be approximated by dividing the coefficients reported in Table A4 by 3.67)

^b See note b, Table 4 for definition of marginal effects.

* significant at 1%

** significant at 5%

***significant at 10%

Table 7A: Reform effects as captured by the impact of successive cohorts on **labor force participation (LFP) rates. Non-pensioner sample.** (Calculations shown in percentage points)^a

	AGE GROUP		
	Age 50 - 59	Age 60 – 64	Age 65 – 70
	Average LFP rates at start—non-pensioners		
Estimated LFP rates of <i>non-pensioners</i> in COH ₀	94.80*	87.77*	74.79*
	Marginal Effect of successive cohorts—non-pensioners ^b		
Coh ₁	0.41	0.37	-2.14
Coh ₂	-0.24	2.36	8.66*
Coh ₃	0.58	1.77	-1.64
Coh ₄	0.71	0.15	4.64
Coh ₅	0.35	0.97	
Coh ₆	-0.15		
	Total post reform effect—non-pensioners		
Last COH obs. relative to COH ₁	1.26**	5.25**	11.66*

Table 7B: Reform effects as captured by the impact of successive cohorts on **labor force participation (LFP) rates. Pensioner Sample.** (calculations shown in percentage points)^a

	AGE GROUP		
	Age 50 - 59	Age 60 – 64	Age 65 – 70
	Average LFP rates at start—pensioners		
Estimated LFP rates of <i>pensioners</i> in COH ₀	27.67*	18.62*	11.84*
	Marginal Effect of successive cohorts--pensioners ^b		
Coh ₁	-8.57*	-7.32*	-0.22
Coh ₂	0.83	2.02	4.79**
Coh ₃	-0.38	10.85*	8.51*
Coh ₄	6.23***	9.43**	1.37
Coh ₅	14.43*	7.07	
Coh ₆	7.20		
	Total post reform effect--pensioners		
Last COH obs. relative to COH ₁	28.32**	29.37**	14.67**

Results based on model reported in Tables A6 and A7

^a See note a, Table 4. Results for Tables 7A and 7B are based on models reported in Table A5. (The marginal effects of other covariates can be approximated by dividing the coefficients reported in Tables A6 and 7 by 8.68 and 3.68, respectively).

^b See note b, Table 4 for definition of marginal effects.

* significant at 1%

** significant at 5% ;

***significant at 10%

Figure 1

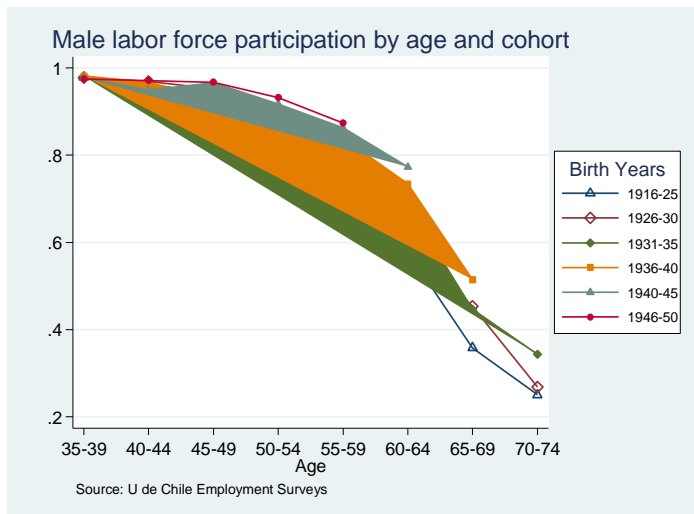


Figure 2

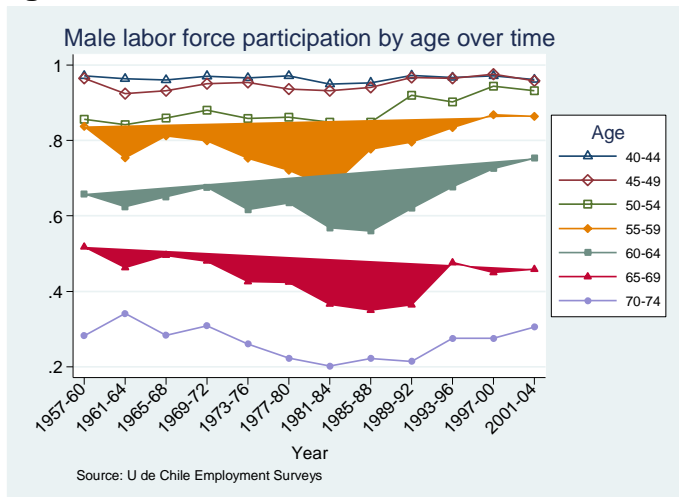


Figure 3

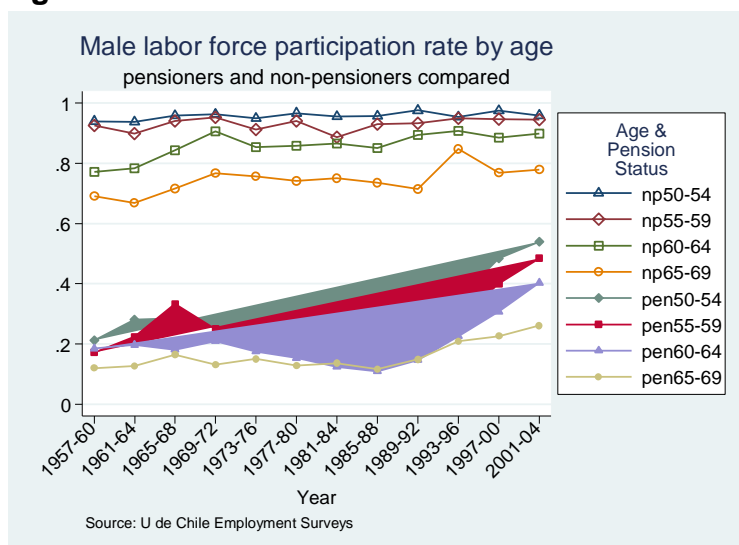


Figure 4

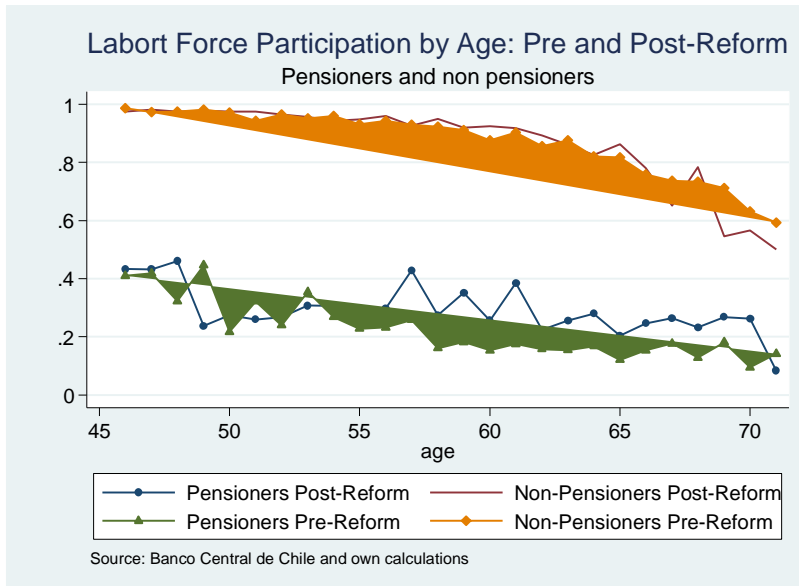
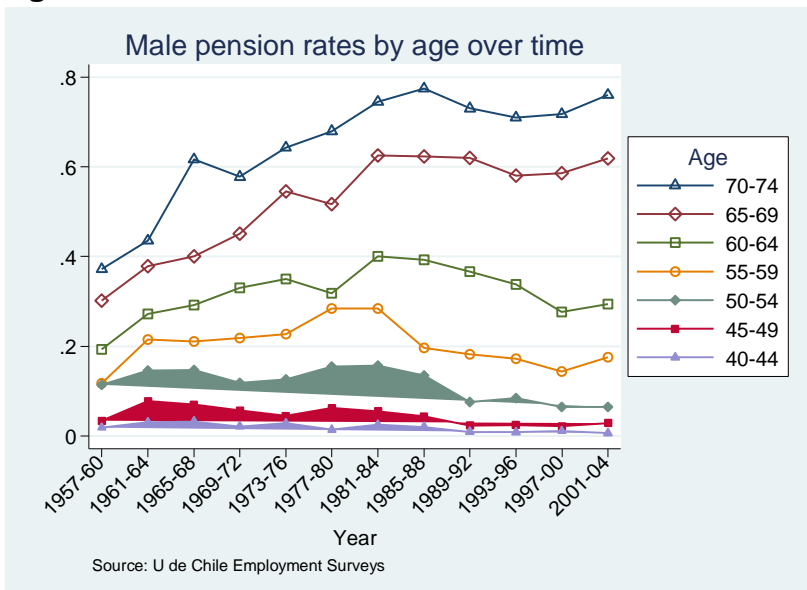


Figure 5



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Endnotes

¹ For preliminary descriptive statistics on labor supply impact see Edwards and Edwards (2002). Gruber (1997) studied the incidence of the payroll tax in Chile.

² If equation (4) holds, then, by definition, equation (2) also holds. However, it is possible for equation (2) to hold for incremental contributions and postponed pension age, with given mortality rates, even if equation (4) does not hold when mortality rates change. For example, the U.S. attempts to adjust monthly benefits for postponed pensioning in an actuarially fair manner, but does not adjust for changing expected lifetimes.

³ This discussion assumes that insurance companies issuing the annuities or pensions in actuarially fair systems are aware of the higher expected lifetime, hence reduce the monthly payout unless retirement savings increase commensurately. It is possible to design DB payouts so that they too adjust downward when longevity increases but most countries, including Chile's old system, do not do this.

⁴ These descriptions are based on SAFP 2003, Cheyre 1991 and personal communications with Augusto Iglesias, Primamerica Consultores.

⁵ While employers paid 2/3 of the 23% tax in the old system, workers pay the entire tax in the new system, an increase from 7.25% to 12.5% of wages. In the short run, wage increases were legally required for workers who switched, to compensate for the tax saving to employers and new tax paid by workers. In that case, gross and net wages would have increased. We don't know how effectively that requirement was implemented or how markets responded to the changed tax rate. Real wages have risen, on average, about 2% per year over the last 25 years.

⁶ Until 2002 workers had a choice of investment manager but virtually no choice of investment strategy. Since 2002 greater choice of investment options has been allowed but this is still limited to 4 or 5 portfolios. Workers who wish to put all their funds into stocks or foreign investments are not allowed to do so. Investment options during the payout phase are even more tightly constrained. Until 2004 only fixed annuities or gradual withdrawals based on conservative investments were allowed.

⁷ The estimate of a 50% implicit tax is based on wage differentials between workers who pay the payroll tax and get benefits versus those who don't (Edwards and Edwards 2002). For a related UK analysis see Disney 2004.

⁸ There were some variations by sub-system. Retirement age was even lower before the old system was reformed, for fiscal reasons, in the late 1970's. Early retirement and evasion resulted in a contributor/ pensioner ratio of 2.2 in 1980, lower than in the U.S. today, despite a much younger population in Chile.

⁹ Although these restrictions appear to be high, the majority of pensioners since 1988 have been early pensioners, consistent with our expectation that most individuals will start their pension as soon as possible. The implied age of eligibility varies widely across individuals, so we do not expect bumps in retirement at any particular point until age 65.

¹⁰ Several other forces in the new system may lead to some postponement of pensioning. Non-pensioners who contribute get access to disability and survivors insurance at a community rate that is advantageous (below true risk cost) for older workers; they lose this access once they start their pension. Some low-pension retirees will be entitled to a higher minimum pension guarantee if they start their pension later; they will gain if they postpone pensioning. Those with less than 20 years of contributions may delay pensioning until they meet this condition for eligibility for the MPG. Finally, pensions are taxable so postponing pensions also postpones taxes.

¹¹ This applies directly to involuntary postponement due to tighter early retirement pre-conditions. Individuals who have voluntarily postponed pensioning will take liquidity constraints into account, and will make a joint decision about pension age and work. Actuarial fairness could then lead them to postpone pension age and continue working longer as non-pensioners, simultaneously.

¹² At any given point in time, about 60-70% of the labor force contributes. Most men have contributed at some point during their working lives, but some of them only sporadically (Arenas et al 2006; Berstein, Larrain and Pino 2005).

¹³ The new system contains a minimum pension guarantee (MPG), which has several implications for work incentives that are complex, partially conflicting and apply to only a small subset of individuals—those with low earnings and a partial history of contributions. Twenty years of contributions are required for eligibility. Low earners therefore have a large incentive to work long enough to become eligible, but to stop work thereafter. To ascertain the impact of the MPG on work and pension behavior requires detailed individual-level information on employment histories and accumulations that our data set does not provide. The government has recently started replacing the MPG with a means-tested basic benefit that will be targeted toward the 60% poorest households in the economy, including non-contributors, creating yet another set of incentives. Women are major recipients of the MPG and the basic benefit. We reserve this topic for further investigation using a different data set and focus on the broader incentives outlined above, in this paper.

¹⁴ Initially we measured single-year cohort trend lines without distinguishing among age groups—one underlying trend starting with the cohort born in 1916 and a drift from this trend starting with the cohort born in 1931—the post-reform effect. This reform effect on LFP had a significant main coefficient of 1.35 percentage points per cohort year and a negative quadratic term that would eventually bring the transition to a close. However, for reasons just given, we believe that allowing the marginal reform effect to vary by cohort and age group is more justifiable.

¹⁵ This routine is part of a suite of Stata programs for interpreting statistical results. See Michael Tomz, Jason Wittenberg and Gary King, 2003. CLARIFY: Software for Interpreting and Presenting Statistical Results. Version 2.1. Stanford University, University of Wisconsin, and Harvard University. January 5. Available at <http://gking.harvard.edu/>.

¹⁶ All actuarial calculations in this paper assume a 5% real interest and discount rate and 2% real wage growth. The actual real rate of return to pension funds in Chile during the post-reform period was over 10%. The interest payable on government bonds was lower. Of course, everything else did not remain constant over this period. For example, accumulations grew and interest rates fell (implying temporary capital gains), which would have changed the monthly benefit, even if longevity were unchanged.

¹⁷ Based on cumulative effects for full sample, no pension controls, using 2.5:1 weighted average of ages 50-59 and 60-64 in Table 5.

¹⁸ This calculation assumes an actuarial factor for a joint annuity of 12.5, an interest rate on pre-pension investments of 5%, a replacement rate of 50% of earnings (the most common replacement rate in Chile, since this was the early retirement threshold), and an income-smoothing savings rate between ages 50-64.

¹⁹ Younger workers must work to consume and the labor market does not make it easy for them to marginally adjust their hours of work. Older workers have access to an alternative income source—a pension—and can withdraw from the labor force completely.

²⁰ But note that exit from the labor force is postponed after 65, despite a likely life cycle increase in preference for leisure time—we attribute this to tax exemption in the new system.

²¹ The DC scheme could be funded, as in Chile, or pay-as-you-go, as in Sweden. One reason why some countries have adopted notional (PAYG) DC schemes is that this enables them to get the labor market incentives of DC, without incurring the transition costs inherent in funding.

²² As examples from other countries: Removal of the retirement earnings test (a high implicit tax rate on pensioner wages) has produced a large increase in work propensities of older individuals in the DB system in the U.S. (Song and Manchester 2006). When New Zealand phased in an increase in its pension age from 60 to 65 during the 1990's, participation rates of men age 60-64 more than doubled—from 32% in 1992 to 67% in 2004 (Baily and Kirkegaard, 2009). Denmark is planning to increase retirement age on par with increases in life expectancy, starting in the 2020's. Sweden's notional DC plan, Finland's DB scheme and the sustainability factor in Germany's point system have tied monthly benefit amount to life expectancy, but they do not directly affect retirement age.