# AGE SEGMENTATION IN THE CHILEAN HEALTH SYSTEM

MARCELO TOKMAN R.

**Abstract**

*A formal model of the Chilean dual health system is presented, which, for appropriate parameters, replicates the observed age segmentation of the population between the private insurance market and the public health insurance. The model is used to compare the level of welfare obtained in the current mixed system with the levels of welfare that could be obtained in alternative "pure" systems, either only private or only public. It is also used to determine how the result of this comparison is affected by intergenerational distribution of income. Finally, the model is used to show that the creation of a mandatory individual savings account to finance the elderly's health insurance could improve the performance of the Chilean health sector by reducing intergenerational inequality.*

**Resumen**

*Se presenta un modelo formal del sistema dual de salud chileno, el cual, para valores de parámetros apropiados, replica la segmentación por edad observada entre los seguros de salud privados (ISAPREs) y el seguro público (FONASA). El modelo se utiliza para comparar el nivel de bienestar alcanzado en el actual sistema mixto con los niveles que podrían ser alcanzados con las alternativas "puras", ya sea sólo seguros privados o sólo un seguro público. También se usa para determinar cómo el resultado de esta comparación es afectado por la distribución intergeneracional de ingreso. Finalmente, el modelo es utilizado para mostrar que la creación de cuentas de ahorro individuales obligatorias, para financiar los seguros de salud durante la vejez, puede mejorar el desempeño del sistema de salud chileno al reducir la desigualdad intergeneracional.*

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□ Ph. D. in Economics, University of California at Berkeley.

## 1. Introduction

During Chile's Pinochet government (1973-1990) several reforms aimed to expand the importance of markets and to decrease the extent of state intervention in economic activity were carried out (i.e. privatization of public enterprises, trade liberalization, pension fund reform, etc.)[1]. One of these structural reforms was the health sector reform of 1982, which transformed a traditionally redistributive social security system into a mixed system with both private, and public health insurance. The legal framework and financing mechanisms to support the development of prepaid private health insurance plans were established and people were given the choice of insuring themselves with either one of these private plans offered by private health insurers, ISAPREs, or with the public insurance offered by the public health insurer, FONASA.

As opposed to the case of the other reforms, the health sector reform has not been widely accepted because of its many problems. In addition to the problems common to all private health insurance, such as the under-provision of preventive services or the rising costs, the mixed nature of the Chilean system has resulted in a troublesome segmentation of the population: the elderly and the population with costly diseases end up in the public health sector. This segmentation not only increases the need of public financing but, more seriously, it also creates a climate of insecurity among the affiliates of the private sector. The unmistaken perception among these people is that their private plans are extremely convenient while they are young and healthy but, contrary to the logic of an insurance, when they become old or fall ill they are forced to abandon these plans and switch to FONASA. The problems of the health sector have generated a rich, but rather informal, discussion between political and corporate actors, and health experts. In terms of the diagnosis, there is a somewhat broad consensus that the cause of the system's segmentation is inherent to its mixed nature. Given the current institutional framework, the observed segmentation seems to be the result of optimal decisions by ISAPREs and their clients.

In terms of the proposed solutions, the consensus is broken. Some propose radical reforms to terminate the system's mixed structure by either having only private insurance or only public ones, while others propose minor reforms within the current framework. In the following section of the paper, we describe the current legal and institutional framework of the Chilean health sector.

In the third section of the paper we provide the first attempt, to our knowledge, to formalize the discussion by developing a formal model of the Chilean health sector. We use the model to address the age segmentation problem, although the same framework could be used to analyze the problem of chronic and catastrophic diseases. In the fourth section of the paper the model is used to compare the proposed "pure" private or "pure" public alternatives with the current mixed institutional framework. In the fifth section we also examine whether altering the discount factor and the intergenerational distribution of income changes the results obtained in the preceding sections. In section six we propose a change within the current legal framework that would improve the performance of the Chilean health system. In the last section we conclude.

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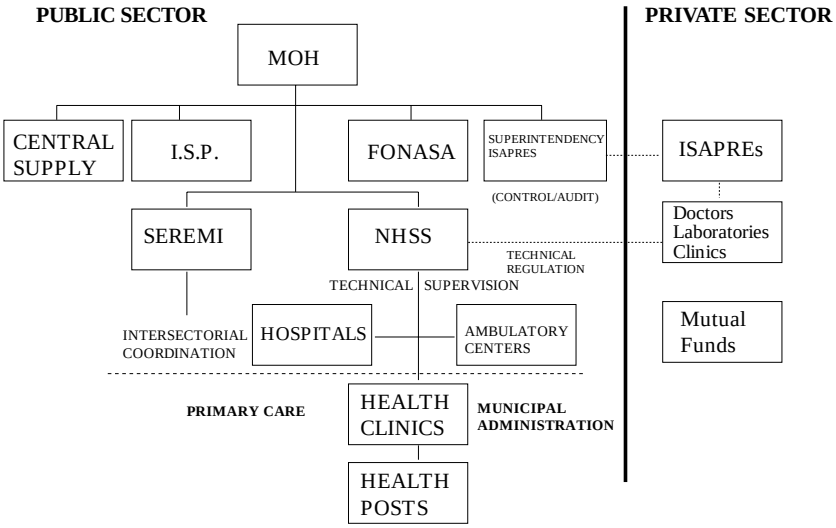
[1] See Diamond and Valdés (1994).

## 2. The Chilean Health System

The Chilean health sector was reorganized in the 1980s through a series of reforms that: decentralized the National Health Service's regional service areas into the National Health Service System (NHSS); assigned the responsibility and allocated resources for primary health care to the municipalities; created FONASA[2], a financial institution to administer the public health sector resources; and established the legal framework and financing mechanisms to support the development of prepaid private health insurance plans, ISAPREs[3] (Miranda (1990), Oyarzo and Galleguillos (1995)). In 1990 the Superintendence of ISAPREs was created. The resulting institutional structure, characterized by a complex combination of public and private providers and financial agencies, is shown in Figure 1[4].

FIGURE 1
ORGANIZATION OF THE HEALTH SECTOR




### 2.1. Publicly Financed Health Services

All active and pensioned salaried workers must pay 7% of their income to the health system. The payment can be made either to FONASA, in which case the worker and his dependents are assigned to the public health system, or to one of the ISAPREs, in which case they are assigned to the private health system. Access to FONASA and the public health system is not restricted. Any worker who chooses FONASA is accepted. Moreover, persons without any in-

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2 FONASA stands for Fondo Nacional de Salud.
3 ISAPRE stands for Instituciones de Salud Previsional.
4 Figure 1 is reproduced from World Bank (1995).

come and their families are also assigned to the public health system. In 1998 62% of the population was covered by FONASA[5].

The type of insurance offered by FONASA is a redistributive social security type in which the benefits received are independent of the payments made. Affiliates of FONASA have two options. The "Institutional" system grants them access to the primary care system managed by the municipalities and to the NHSS facilities. The "Preferred Provider System", open only to paying affiliates, grants them access to a group of private providers[6]. These private providers (physicians, hospitals and clinics) are reimbursed on a fixed price basis for specific ambulatory and inpatient medical services. FONASA pays a portion of the price and the users pay the other part with a voucher purchased from FONASA.

FONASA's main sources of revenues are: "cotizaciones" or transfers granted by the mandatory 7% payroll deductions of workers not affiliated to any ISAPRE, which account to 33% of total income; central government contributions which account for another 48%; the sale of vouchers under the "Preferred Provider System" representing 7%; and other sources for the remaining 12%[7]. In addition to these resources, capital investments in the health sector are financed through the National Regional Development Fund of the Ministry of Interior. The municipal-run primary health care network is financed partly by FONASA and the rest by the municipalities' budgets.

### 2.2. Private Pre-Paid Health Insurance Schemes

In addition to the "Preferred Provider System", health care is also provided in the private sector through 29 prepaid health insurance schemes (ISAPREs), which covered 23% of the population in 1998. Eighteen of the ISAPREs are "open" and will enroll all applicants meeting the eligibility criteria of individual ISAPREs. The other 11 are "closed" and only enroll employees from specific enterprises for which the ISAPRE was created. Over 95% of the ISAPRE beneficiaries belong to the "open" ISAPREs.

ISAPREs offer subscribers and their dependents both outpatient and inpatient care on a cost-sharing basis via their own facilities or under contract with private or public providers. ISAPRE affiliates pay a monthly premium that varies according to the cost of the policy they choose to purchase. In 1995 ISAPREs offered 8800 different plans. Plans differ in the level of financial protection offered (copayments, internal and external limits on coverage), the access to different physicians and hospitals and the list of excluded medical services. Prices of the different plans depend on the medical risk (probability and magnitude of the expected expenditure) of the subscriber.

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5 This figure does not include the 3% of the population covered by parallel public health services under the armed forces and public enterprises. (Source: CASEN 1998)

6 In 1992, 78% of physicians in the country provided services under the "Preferred Provider System"

7 See Larrañaga, O. (1997).

The subscribers must pay the obligatory 7% salary deduction and they may also decide to make an additional payment to improve the coverage of the plan. ISAPREs also receive a series of public subsidies. One of them is a tax rebate to employers who contribute an additional 2% of payroll to complement the compulsory 7% salary deduction used to pay ISAPRE premiums for low income employees[8]. Other subsidies correspond to public health programs such as maternity leave payments, free distribution of vaccines and food supplementation products to ISAPREs' members.

The decision to join an ISAPRE is not unilateral as in the case of FONASA. ISAPREs have the right to reject interested workers. Until 1990 they also had the right to terminate unilaterally the contract by not renewing them at the end of the contract's period (1 year). Formally, since 1990 ISAPREs can not terminate them unilaterally. However in practice they can since ISAPREs are allowed to change the terms (coverage and price) of the plans.

## 2.3. Problems

Researchers have identified several problems in the Chilean health system. Some of them are common to any health insurance market, but others seem to be associated to the dual nature of the Chilean system. The problems shared by most competitive health insurance markets are the under-provision of preventive services (Musgrove, 1996) and the booming costs (Hoffmeyer and McCarthy (1994)). The problems presumably due to the coexistence of a private and a public health insurance system are the low coverage of catastrophic diseases, the low level of protection for the elderly and their combined effect over the financing requirements of the public sector.

### 2.3.1. *Catastrophic Diseases*

One of the problems of the Chilean mixed health system is the ISAPREs' low coverage of catastrophic diseases[9]. Díaz, Gazitúa, Torche and Valdés (1995) report that coverage decreases with the cost of the disease. They show that only 55% of the expenditures of high cost diseases are covered by ISAPREs.

Due to adverse selection, ISAPREs may end up with a pool of high-risk participants that can destabilize an insurance pool and even cause it to fail (Chollet and Lewis, 1997). To avoid or at least reduce the adverse selection problem, ISAPREs follow several procedures. First, they evaluate individual health status and reject potential buyers who are deemed to pose excessively high risk. Second, they design and offer health care plans with adequate coverage for outpatient services but with poor coverage for high cost illnesses and specific expensive procedures. By law ISAPREs are allowed to: exclude preexisting conditions for up to 18 months, exclude coverage for specific diseases and services and set internal and external limits on coverage. Third, they dis-

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8 The Executive has sent to Congress a law to eliminate this 2% subsidy. This law is currently being discussed in the Congress.

9 Catastrophic diseases are high-cost diseases that can put a family in a situation of financial insolvency. They can be either high unit cost events or diseases that require high periodic expenditures.

criminate (and eventually terminate the contract of) those subscribers with high cost chronic diseases. Although by law, ISAPREs are not permitted to terminate a contract unilaterally, they actually can do it by changing the contract's conditions and induce the subscriber to abandon the ISAPRE at the end of the year when the contract is due for renewal (Bitrán and Almarza, 1997).

Researchers also cite the existence of an open public insurance that does not have any (formal) limits nor exclusions as a cause of the low coverage provided by ISAPREs for catastrophic diseases (Fischer, 1998; Fischer and Serra, 1996; Díaz, Gazitúa, Torche and Valdés, 1995). According to them, consumers' optimal behavior is to use ISAPREs to obtain access to good quality outpatient services and to switch to FONASA if a catastrophe occurs.

### 2.3.2. *Protection for the Elderly*

Another problem of the Chilean health system is the low level of protection given to the elderly. The short-term competitive nature of the private health insurance markets forces the ISAPREs to attempt to price insurance based on the enrollees' medical risk. Since the law allows ISAPREs to discriminate by age, the price of all the plans offered by them rise significantly, as the affiliate grows older. The prices paid by affiliates of 60 and more years of age is 2 to 5 times higher than those paid by 18 to 34 year old men (Bitrán and Almarza (1997)). If an ISAPRE attempted to avoid tiered rating, making health insurance more affordable to old (high risk) people by forcing other members of the pool to subsidize them, it would end up with young (low risk) members fleeing to low cost insurance. Tiered rating is the natural outcome in this market.

In 1998 less than 7% of the population over 65 remained enrolled to an ISAPRE. It is very likely that a person that has been subscribed to an ISAPRE during his young and adult years will be forced to abandon the system and switch to FONASA when he turns old and his expected health expenditures increase substantially. It is this situation that gives the ISAPRE system its worst publicity in opinion polls. People express their disconformity with the system that abandons them when they are most vulnerable (Larrañaga (1997)).

### 2.3.2. *Fiscal Pressure*

The low level of protection given to the elderly and the low coverage of catastrophic diseases by ISAPREs results in a segmentation of the population that exerts considerable pressure on the public system's finances. People subscribe to the private health system while they remain healthy and earning high incomes. Once their medical risk increases and/or their income falls (i.e. due to sickness or retirement), they are forced into the public health system which acts as an implicit reinsurance. FONASA ends up with the segment of the population that has the highest expected expenditures and pays the smallest "cotizaciones" to the health fund[10]. FONASA must rely on central government

[10] Espinosa (1997) reports that the percentage of ISAPREs' active enrollees that in 1995 earned incomes higher than CH$ 250,000 was 50%, while it was less than 4% of FONASA's enrollees.

contributions in order to provide adequately the medical services that its subscribers require. Chile's current epidemiologic and demographic transition, which has resulted in the aging of the population and the increased importance of non-communicable diseases, will make FONASA's dependence on fiscal resources even more severe.

### 2.4. Proposed Solutions

There is a certain degree of consensus between researchers and the relevant political and gremial actors that the coexistence of two systems in the Chilean health sector "distorts" the distribution of health risks between the two systems. Researchers cite the current mixed structure of the system, with both a private health insurance market and a "last resource" public insurance, as one of the main causes of the observed segmentation of the market and the corresponding low level of protection offered by the ISAPREs for catastrophic diseases and the elderly (Fischer (1998), Fischer and Serra (1996) and Díaz, Gazitúa, Torche and Valdés (1995)).

According to the same study, the political parties in the opposition, Renovación Nacional and Unión Democrática Independiente, and the owners of the ISAPREs also prefer a "puritan" solution. They see "the privatizing of the insurers and the providers as the solution" (p. 18) to the sector's problem. On the other hand, the political parties in the CONCERTACION, the ruling coalition, prefer to make minor adjustments rather than proposing the structural transformation of the sector.

Most academic researchers propose changes within the current mixed structure of the sector. Fischer, Mizala and Romaguera (1998) propose the creation of a compulsory individual savings account to finance the increased prices of the elderly's health insurance plans. According to Fischer (1998), Fischer and Serra (1996) and Aedo and Torche (1996) what should be compulsory is the purchase of a minimum health plan as opposed to the current obligation of spending a fixed portion of income on health insurance. The minimum health plan would be offered by either FONASA or one of the ISAPREs and it should cover a basic basket of services necessary to have an adequate level of protection. Fischer (1998), Fischer and Serra (1996) and Díaz, Gazitúa, Torche and Valdés (1995) propose the development of a short-term insurance system a la Cochrane (1995) which would pay the expected future cost of an affiliate that suffers a chronic disease and wants to switch plan and/or ISAPRE. Fischer (1998) argues that the problem of low coverage of catastrophic diseases can be solved by establishing a second floor insurance system. With this system, people would continue affiliated to an ISAPRE as they currently do. And if they suffer an extremely costly event, there is an expenditure threshold over which the reinsurance would start to operate by covering the extra costs.

In the following section we develope a model of the Chilean health sector which is used to determine whether its current structure yields a higher level of welfare than the "pure" solutions, and whether its performance can be improved by creating compulsory individual saving accounts.

## 3. The Model

### 3.1. Assumptions

Total population in period t is $N(t)$ and it grows at a constant rate. Individuals are identical and live for two periods. A portion $\mu_y$ of them are living their first period of life. The remaining $\mu_o N(t)$ are living their second and last period[11]. Their life-time utility $W$ is the sum of each period's state-independent, strictly concave and increasing Von Neumann-Morgenstern utility functions $U(.)$ discounted by $\beta$.

When they are young, in their first period of life, they work and earn income $w_y$. When old, in their second period of life, they retire and receive a pension $w_o$, $w_y \geq w_o$. The second-period pension is financed from first-period compulsory contributions made to their individual retirement accounts. First-period income $w_y$ corresponds to net income, after retirement contributions. There is no voluntary personal savings[12].

If they contract a disease they have to undergo a treatment which may fully restore their health. The cost of such a treatment while they are young is $d_y$ and $d_o$ when they become old, $d_y \leq d_o$. The probability of falling ill while young is $p_y$ and $p_o$ while old, $p_y \leq p_o$. There is no asymmetry of information, agents and insurance offering institutions know all the above information.

Agents are required by law to purchase health insurance from either one of the competitive risk-neutral private ISAPREs or from the public sector's FONASA. Health insurance is offered through contracts $(\alpha_i, \gamma_i)$ for $i = y, o$, where agents pay a premium $\alpha_i$ if they do not fall ill and are paid $\gamma_i$ in case of illness as a contribution to treatment costs. The law sets a minimum purchase of insurance defined in terms of the agent's income level, $\alpha_i \geq f w_i$. The law also establishes that the premium charged by FONASA must be equal to this minimum payment. All agents, independent of the type of insurance they purchase, must pay a lump-sum tax $\tau$ which is used to finance the fiscal contribution to FONASA. Expected life-time utility is then:

$$W = V_y((\alpha_y, \gamma_y), \tau) + \beta\, V_o((\alpha_o, \gamma_o), \tau), \tag{1}$$

where $V_y((\alpha_y, \gamma_y), \tau)$ and $V_o((\alpha_o, \gamma_o), \tau)$, are expected utility of a person while young with insurance contract $(\alpha_y, \gamma_y)$ and tax $\tau$ and expected utility of a person while old with insurance contract $(\alpha_o, \gamma_o)$ and tax $\tau$, respectively. Thus,

$$W = (1 - p_y)U(w_y - \tau - \alpha_y) + p_y U(w_y - \tau - d_y + \gamma_y) +$$
$$\beta[(1 - p_o)U(w_o - \tau - \alpha_o) + p_o U(w_o - \tau - d_o + \gamma_o)]$$

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11 Since population is growing at a constant rate, $\mu_y$ and $\mu_o$ are not time-dependent.

12 This assumption, which greatly simplifies the solution of the model, is appropriate for the Chilean economy. In a study about the behaviour of savings in Chile, Valdés (1997) states that voluntary personal savings, personal savings after substracting retirement contributions, is and has been null.

Agents maximize their expected life-time utility by choosing their preferred insurance contract from the set of private ones offered by the ISAPREs and the public ones offered by FONASA.

There are no barriers to entry nor exit in the private insurance market, ISAPREs have no overhead costs, contracts are individual and they last for only one period therefore expected profits for each of the individual contracts offered by ISAPREs must equal zero:

$$E\pi = (1 - p_i)\alpha_i - p_i\gamma_i = 0 \quad for\ i = y, o$$

The zero expected profit condition plus the minimum legal requirement imply that the set of private contracts available are $(\alpha_i^P \geq fw_i, ((1-p_i)/p_i)\alpha_i^P)$ for $i = y, o$ where the level of $\alpha_i^P$ is determined by the purchaser.

FONASA offers just two contracts: ($fw_y$, $\gamma_y^F$) to young individuals and ($fw_o$, $\gamma_o^F$) to old ones. Each period FONASA faces the following budget constraint:

$$(2)\quad \tau N(t) + ((1-p_y)x_y\mu_y w_y + (1-p_o)x_o\mu_o w_o)fN(t) = (p_y x_y \mu_y \gamma_y^F + p_o x_o \mu_o \gamma_o^F)N(t)$$

where $x_y$ and $x_o$ correspond to the share of the young and the old that opt for the public insurance scheme. The left hand side corresponds to expected revenues, the tax-financed fiscal contribution plus the expected premiums payed by its affiliates, and it must equal expected expenditures, the right hand side of the equation.

FONASA is a redistributive social security type of insurance in which the benefits received are independent of the payments made. Therefore, except for one case,

$$(3)\qquad \gamma_y^F = \gamma_o^F = \frac{\tau + ((1-p_y)x_y\mu_y w_y + (1-p_o)x_o\mu_o w_o)f}{p_y x_y \mu_y + p_o x_o \mu_o}$$

The exception[13] would occur if

$$(\tau + ((1-p_y)x_y\mu_y w_y + (1-p_o)x_o\mu_o w_o)f / (p_y x_y \mu_y + p_o x_o \mu_o)) > d_y$$

because benefits are meant to be contributions to the treatment costs in case of illness and therefore they can not exceed them. In this case

$$(4)\ \gamma_y^F = d_y \ and\ \gamma_o^F = \frac{\tau + ((1-p_y)x_y\mu_y w_y + (1-p_o)x_o\mu_o w_o)f - p_y x_y \mu_y d_y}{p_o x_o \mu_o}$$

Individuals must select their preferred health insurance for each of the two periods from the available public and private ones. In doing so they will com-

[13] Given the parameter values that will be used in this paper, the exception is not relevant.

pare the benefits that they would obtain from the best private plan they can purchase with those of the plan offered to them by FONASA. The advantage of selecting a private insurance is that individuals are not restricted to purchase a fixed quantity. As opposed to the FONASA plan, each individual may purchase the amount of insurance optimal for him, as long as it is not less than the legal minimum. The advantage of selecting the FONASA plan is that it allows them to benefit from the fiscal contribution. Another difference between the two types of schemes is that the prices of private ones are actuarially fair while the prices of the FONASA plans incorporate a cross-subsidy component. Since all of FONASA's affiliates are pooled together, young low- risk individuals that decide to insure themselves with the public insurance end up cross-subsidizing old high-risk agents.

In the following section backwards induction is used obtain each period's optimal health insurance choice for individuals facing an exogenously determined menu of health plans.

### 3.2. Expected Life-Time Utility Maximization

Individuals choose their preferred health insurance plan to maximize their expected life-time utility. In each period they take the menu of plans offered by ISAPREs and FONASA as given. Since in the second period, first period decisions and actions have been taken and first period health events have already occurred, old individuals take first period utility as given when choosing their preferred health plans. Following a backwards induction process, young agents will choose their preferred plans taking as given the optimal second period choices.

Thus, the second period decision is:

$$\underset{(a_o^*,\gamma_o^*)}{Max}\, V_o((\alpha_o,\gamma_o),\tau) = (1-p_o)U(w_o-\tau-\alpha_o) + p_oU(w_o-\tau-d_o+\gamma_o)$$

*subject to*

$$(\alpha_o^*,\gamma_o^*) \in \left(\alpha_o \geq fw_o, \frac{(1-p_o)}{p_o}\alpha_o\right) \cup (fw_o,\gamma_o^F)$$

The maximization yields that old individuals will fully insure themselves by purchasing $(\alpha_o^*,\gamma_o^*) = (p_od_o,(1-p_o)d_o)$ from an ISAPRE if $V_o((p_od_o,(1-p_o)d_o),\tau) \geq V_o((fw_o,\gamma_o^F),\tau)$. Otherwise, if $V_o((p_od_o,(1-p_o)d_o),\tau) < V_o((fw_o,\gamma_o^F),\tau)$ agents will contract $(\alpha_o^*,\gamma_o^*) = (fw_o,\gamma_o^F)$ from FONASA.

In their first period, young agents maximize their life-time utility *W* taking the second period decision $(\alpha_o^*,\gamma_o^*)$ as given:

$$\underset{(a_y^*,\gamma_y^*)}{Max}\, V_y((\alpha_y,\gamma_y),\tau) + \beta V_o((\alpha_o^*,\gamma_o^*),\tau) =$$

$$(1-p_y)U(w_y-\tau-\alpha_y)+p_yU(w_y-\tau-d_y+\gamma_y)$$
$$+\beta[(1-p_o)U(w_o-\tau-\alpha_o^*)+p_oU(w_o-\tau-d_o+\gamma_o^*)]$$

*subject to*

$$(\alpha_y^*,\gamma_y^*)\in\left(\alpha_y^*\geq fw_y,\frac{(1-p_y)}{p_y}\alpha_y^*\right)\cup(fw_y,\gamma_y^F)$$

First order conditions yield that young individuals will fully insure themselves by purchasing $(\alpha_y^*, \gamma_y^*) = (p_y d_y, (1-p_y)d_y)$ from an ISAPRE if $V_y((p_y d_y, (1-p_y)d_y), \tau) \geq V_y((fw_y, \gamma_y^F), \tau)$. Otherwise, if $V_y((p_y d_y, (1-p_y)d_y), \tau) < V_y((fw_y, \gamma_y F), \tau)$ they will contract FONASA's $(\alpha_y^*, \gamma_y^*) = (fw_y, \gamma_y^F)$.

### 3.3. Solution

In the previous section agents' optimal decisions were obtained assuming that the menu of health contracts offered to them was given and independent of their actions. This section takes into account the fact that the available contracts, particularly the payments made by FONASA in the event of disease $\gamma_y^F$ and $\gamma_o^F$, depend on the agents' decisions. This together with the fact that agents within each of the two age groups are identical and therefore will make the same choices, yields four possible solutions to the model. These four possible Nash-equilibria are: first, agents always choose the public insurance over the available private contracts ($x_y = x_o = 1$); second, individuals choose to insure themselves privately while young and prefer FONASA while old ($x_y = 0$, $x_o = 1$); third, individuals choose FONASA while young and ISAPREs while old ($x_y = 1$, $x_o = 0$); and fourth, individuals always prefer ISAPREs over FONASA ($x_y = 0$, $x_o = 0$).

If the parameter values are such that both of the bellow conditions of a possible equilibrium are satisfied, then the solution to the model will be the corresponding Nash equilibrium. As will be discussed bellow, it is possible that the equilibrium is not unique. However, in those cases the number of equilibria can not exceed two.

#### 3.3.1. $x_y = x_o = 1$

Two conditions must be met for agents to choose FONASA in both periods of their lives: if while old, individuals choose FONASA then while young they must prefer FONASA's plan over any plan offered by ISAPREs; and if while young, individuals choose FONASA then while old they must also prefer FONASA. The first condition can be stated algebraically as:

$$V_y((fw_y,\gamma_y^F[1,1]),\tau)+\beta V_o((fw_o,\gamma_o^F[1,1]),\tau)>$$
$$V_y((p_y d_y,(1-p_y)d_y),\tau)+\beta V_o((fw_o,\gamma_o^F[0,1]),\tau), \quad (5)$$

where $\gamma_i^F[\mathbf{x}_y,\mathbf{x}_o]$ corresponds to $\gamma_i^F$ when $x_y = \mathbf{x_y}$ and $x_o = \mathbf{x_o}$ for i = y, o, which can be obtained from equation 3 and, in the case of the exception mentioned above, from equation 4. The second condition can be expressed algebraically as:

$$V_o((fw_o, \gamma_o^F[1,1], \tau) > V_o((p_o d_o, (1-p_o)d_o), \tau) \tag{6}$$

3.3.2. $x_y = 0, x_o = 1$

The two conditions that must be satisfied for young agents to prefer private health insurance and for old agents to choose FONASA are: if while old, individuals choose FONASA then while young they must prefer a plan offered by an ISAPRE; and if while young, individuals prefer private health insurances then it must be the case that they prefer FONASA when they get old. The first condition can be stated as:

$$\begin{aligned} &V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) \geq \\ &V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau) \end{aligned} \tag{7}$$

The second condition is:

$$V_o((fw_o, \gamma_o^F[0,1], \tau) \geq V_o((p_o d_o, (1-p_o)d_o), \tau). \tag{8}$$

3.3.3. $x_y = 1, x_o = 0$

For the outcome in which only young individuals choose FONASA to be an equilibrium the following two conditions must be satisfied: if while old, individuals choose ISAPREs then while young they must prefer the plan offered by FONASA; and if while young, individuals prefer FONASA then it must be the case that in their second period they prefer private health insurances. The first condition can be stated as:

$$\begin{aligned} &V_y((fw_y, \gamma_y^F[1,0]), \tau) + \beta V_o((p_o d_o, (1-p_o)d_o), \tau) \geq \\ &V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((p_o d_o, (1-p_o)d_o), \tau). \end{aligned} \tag{9}$$

The second condition can be expressed as:

$$V_o((p_o d_o, (1-p_o)d_o), \tau) \geq V_o((fw_o, \gamma_o^F[1,1]), \tau). \tag{10}$$

3.3.4 $x_y = x_o = 0$

Two conditions must be met for agents to choose ISAPREs in both periods of their lives: if while old, individuals choose ISAPREs then while young they

must also prefer one of the private health plans over FONASA's plan; and if while young, individuals choose ISAPREs then while old they must also prefer ISAPREs. The first condition can be stated algebraically as:

$$V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((p_o d_o, (1-p_o)d_o), \tau) > V_y((fw_y, \gamma_y^F[1,0]), \tau) + \beta V_o((p_o d_o, (1-p_o)d_o), \tau). \quad (11)$$

The second condition is:

$$V_o((p_o d_o, (1-p_o)d_o), \tau) > V_o((fw_o, \gamma_o^F[0,1], \tau). \quad (12)$$

Before proceeding any further it must be noted that in the last three possible equilibria, which consider situations in which neither the active workers nor the elderly choose FONASA, it has been assumed that tax $\tau$ will continue to be collected despite the fact that no fiscal contribution to FONASA would be required, and that agents do not obtain any utility from other types of public spending financed with these tax revenues. What we have in mind is that if it is the agents that choose independently not to use FONASA, the government will continue collecting the tax and use the revenues to finance social spending targeted to a group of individuals, the unemployed indigent population, that has not been (and, for simplicity, will not be) considered explicitly in the analysis[14]. This situation contrasts with another possible case analyzed bellow in which FONASA ceases to exist as part of a legal and institutional reform. In this case, the elimination of FONASA would also involve a tax reform to eliminate tax $\tau$.

As mentioned above, there are parameter values for which more than one of the equilibria, but not more than two, are possible. The upper limit is due to the fact that the conditions of each of the equilibria necessarily imply that the conditions of other two equilibria can not be satisfied. In fact, the pair of equilibria one and four and the pair of equilibria two and three are mutually exclusive. If the parameters are such that the conditions for the first or the fourth equilibrium hold then the conditions for the second and third equilibrium will not hold, and vice versa. (Condition 5 is the negation of 7 and 6 is the negation of 10. Also condition11 is the negation of condition 9 and condition 12 is the negation of 8).

In the following section we make some simplifying assumptions about the functional form of the preferences and we use parameter values that fit the Chilean health sector and yield the observed age segmentation between the two sub-systems.

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[14] A more general case in which young and old agents derive some utility from the public sector's spending can be considered by letting $V_i((p_i d_i, (1\text{-}p_i)d_i), \tau) = V_i((p_i d_i, (1\text{-}p_i)d_i), \varphi_i \tau)$ with $0 \leq \varphi_i \leq 1$ in the situations where all individuals prefer in every period the private health insurance schemes.

## 4. The Chilean Case

### 4.1. Simplifying Assumptions and Parameter Values

Two simplifications concerning the functional forms of preferences are made. First, we use logarithmic utility functions, which are widely used in the literature:

$$U(\cdot) = \ln(\cdot)$$

Second, we assign an specific value to the discount factor:

$$\beta = 0.909$$

Although this discount factor is consistent with several econometric studies (Haussman (1979)), it will be shown in the following sections that the main results of the paper hold for a wide range of values of this parameter.

We let the minimum health insurance payroll deduction equal:

$$f = 7\%$$

which corresponds to the minimum health insurance payroll deduction earmarked from all active and pensioned salaried workers established by the Chilean law.

The age distribution parameters that we use are:

$$\mu_y = 0.8 \text{ and } \mu_o = 0.2$$

These parameters are consistent with the steady state age structure that, according to the World Bank (1995), will be reached by the Chilean population during the first decade of the next century.

The first period income $w_y$ is used as the numeraire:

$$w_y = 100$$

In the base case the replacement rate is equal to 0.8:

$$w_o = 0.8 \qquad w_y = 80$$

According to Serrano (1998) the Chilean fully funded pension funds have in several occasions yielded replacement rates equal to (and often higher than) 80%.

The costs of treating illness used in the model are:

$$d_y = \frac{1}{4} w_y = 25$$

*and*

$$d_o = \frac{1}{2} w_o = 40$$

The probabilities of falling ill used here are:

$$p_y = 0.28$$

*and*

$$p_o = 0.35$$

These values imply that the prices paid by old ISAPRE affiliates is twice the price charged to a young affiliate, which is consistent with the price information presented in the description of the Chilean health system at the beginning of the paper.

The lump-sum tax used in the model is:

$$\tau = 0.728$$

This value is consistent with the above description of the Chilean health system which states that central government contributions to FONASA account for almost half of its revenues[15].

### 4.2. Age Segmentation ($x_y = 0, x_o = 1$ )

The functional forms and parameter values described above result in a unique solution to the model which resembles the actual age segmentation of the Chilean health sector: young agents choose private insurance and old agents prefer FONASA ($x_y = 0, x_o = 1$ ).

Both conditions 7 and 8 of the equilibrium are satisfied:

$$V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) = 8.3682 \geq$$
$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau) = 8.3587$$

*and*

$$V_o((fw_o, \gamma_o^F[0,1]), \tau) = 4.2282 \geq ((p_o d_o, (1-p_o)d_o), \tau) = 4.1786$$

Since the above conditions hold, the necessary conditions of equilibria ($x_y = 1, x_o = 1$) and ($x_y = 0, x_o = 0$) do not hold. The solution is unique because condition 10, necessary for equilibrium ($x_y = 1, x_o = 0$ ), does not hold for these parameter values:

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[15] It could be argued that taking the 48% central government contribution to FONASA as the relevant figure for the model is an overstatement since part of that contribution is used to finance the health services provided to the group of poor agents that have been excluded from the model. However, if the fiscal resources used to finance capital investments and primary health care are also considered then the figure does not seem to be inappropriate.

$$V_o((p_o d_o, (1-p_o)d_o), \tau) = 4.1786 \Rightarrow V_o((fw_o, \gamma_o^F[1,1]), \tau) = 4.2155.$$

As mentioned in the previous section, this result holds for a wide range of discount factors. Condition 7 is satisfied by all values of $\beta \geq 0.16535$. And, since conditions 8 and 10 are independent of the discount factor, they are met by all possible values of the parameter. Therefore, as all conditions must be met, the model yields the observed age segmentation of the Chilean economy for all $\beta \in [0.16535, 1]$.

### 4.3. Welfare with Alternative Institutional Arrangements

In this section the model's specification described above is used to determine whether Chile's current mixed health system is better than a "pure" private and "pure" public alternatives. The convenience of one system over another is evaluated by computing the representative agent's life-time expected utility for each of the institutional arrangements.

We take a "pure" public system to be one in which all agents would purchase the compulsory amount of insurance only from FONASA. FONASA's benefits would remain independent of the prime purchased, and it would continue to receive a tax-financed fiscal contribution. In a "pure" private system there would be no state intervention in this market: agents would purchase their preferred health plans from the menu offered by the ISAPREs, and they would not have to pay a tax to finance the fiscal contribution to FONASA because FONASA would cease to exist.

The three alternative institutional arrangements can be ordered in terms of efficiency and intergenerational equality. The most equitable system is the "pure" public one which uses two redistribution mechanisms: the lump-sum tax and the implicit cross-subsidy. The least equitable system is the "pure" private system which has no mechanism to redistribute income from the young to the old. The current mixed system uses only one of the redistribution mechanisms, the tax financed contribution, and therefore, in terms of intergenerational equality, it is located between the two "pure" systems.

In terms of efficiency, the ranking is inverted. The most efficient system is the "pure" private one because the prices charged are actuarially fair and agents are free too purchase their optimal amount of insurance. The least efficient system is the "pure" public system: prices are not actuarially fair and agents are required to purchase a fixed amount of insurance that might differ from their optimal purchase. In terms of efficiency, the current mixed system is again located between the two alternatives. Prices of the health insurances purchased by young agents are actuarially fair, and if their desired purchase is equal or exceeds the legal minimum then they can also purchase their optimal amount. However for old agents, the current mixed system has the same inefficiencies as the "pure" FONASA system.

To determine the overall ranking of the systems, we compute and compare the representative agent's expected life-time utility[16] using the model's specifi-

[16] Note that since all agents are identical, expected life-time utility is equal for all of them.

cation and parameter values described in the previous section for the three possible institutional arrangements.

Life-time expected utility of an agent under the current mixed system $W_M$ is:

$$V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) = 8.3682$$

Life-time expected utility of an agent under a "pure" public system $W_F$ would be:

$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau) = 8.3587 \quad (13)$$

Life-time expected utility of an agent under a "pure" private system $W_I$ would be:

$$V_y((p_y, d_y, (1-p_y)d_y), 0) + \beta V_o((p_o, d_o, (1-p_o)d_o), 0) = 8.341. \quad (14)$$

Intergenerational equality matters. The systems with redistributional mechanisms yield higher utility than the "pure" private one. However efficiency also matters. Welfare is not maximized by simply choosing the system that maximizes redistribution at any cost. The current mixed system yields the highest welfare by combining some of the redistributional attributes of the public system without sacrificing all the efficiency attributes of the private system.

How important the intergenerational mechanisms of redistribution are depends on the value of the discount factor in the welfare function and degree of heterogeneity between young and old agents. In the base scenario, in which $\beta = 0.909$, $w_o = 0.8w_y$, $d_o = 1.6d_y$ and $p_o = 1.25p_y$, the benefits of redistribution outweighed the efficiency costs. However, a smaller discount factor and higher homogeneity between agents should reduce the importance of the redistribution mechanisms and close the welfare gap between the alternative systems. In the following section we examine how changes in the discount factor and the intergenerational distribution of income might affect the above result.

## 5. Changes in the Discount Factor and in the Intergenerational Distribution of Income

### 5.1. Discount Factor

As discussed in the previous section, the three alternative institutional arrangements, the current mixed health system and the "pure" private and the "pure" public ones, can unambiguously be ranked in terms of intergenerational equality and efficiency. They can also be ranked combining both attributes by evaluating the representative agent's life-time expected utility. When the parameter values of *the Chilean case* were used, intergenerational equality weighted more than efficiency: the mixed system yielded the highest level of life-time expected utility, followed by the "pure" public one while the "pure" private one yielded the lowest level of life-time expected utility. In this section we examine

how the importance of intergenerational redistribution and the relative performance of the alternative institutional arrangements varies with different discount factors.

The value of redistribution from young agents to old agents in the representative agent's life-time utility will obviously depend on the discount factor, which measures the relative value of the second period's utility. A lower discount factor reduces the social value of intergenerational redistribution. In fact, it might be the case that for sufficiently low discount factors, the benefits of intergenerational redistribution obtained with the current system and the "pure" public one are not worth the efficiency costs and that, therefore, the results of the previous section may not hold.

Evaluating life-time expected utility of the representative agent under the three different systems for the parameter values *of the Chilean case* and the values of the discount factor which result in Chile's observed age segmentation, $\beta \in [0.16535,1]$[17], yields three interesting results:

- The convenience of the current mixed system over the other two "pure" alternatives holds for a wide range of values of the discount factor, $\beta \in [0.220519,1]$.
- The ranking of the previous section remains unaltered for a wide range of values of the discount factor, $\beta \in [0.22481,1]$.
- Intertemporal redistribution becomes less important for lower discount factors. This can be observed from the fact that for $\beta > 0.22481$ the "pure" public system yields a higher level of welfare than the "pure" private one, but for $\beta < 0.22481$ it is the "pure" private system that yields a higher level of welfare. The same result can be observed from comparing the mixed system with the "pure" private one. For $\beta > 0.20519$ expected life-time utility with the current mixed system is higher than with the "pure" private one, whereas for $\beta < 0.20519$ it is the "pure" private system that yields a higher level of expected life-time utility.

The first two of the above results are very important because they show that the results obtained in the previous section are very robust for different values of the discount factor. For all plausible values of the discount factor ($\beta$ 0.85) w elfare is maximized with the current mixed system, and a "pure" public one yields a higher level of welfare than a "pure" private one.

### 5.2. Intergenerational Inequality

This section explores the effect of altering the intergenerational distribution of income on the age distribution of the population among the private and public systems within the current institutional framework. It also explores whether the convenience of the current system over the two "pure" alternatives holds for different income distributions.

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[17] Life-time expected utility under each of the alternative is: $W_M = 4.5247 + 4.2282\beta$, $W_F = 4.5268 + 4.2155\beta$ *and* $W_I = 4.5326 + 4.1897\beta$.

To isolate the effect of the changes in the intergenerational distribution of income, the only parameters of the model that are allowed to vary are $w_y$ and $w_o$. And since the focus of this section is solely changes in the distribution and not in the levels, the per capita income is kept constant[18] :

$$u_y w_y + u_o w_o = 0.8(100) + 0.2(80) = 96$$

Thus,

$$0.8w_y + 0.2w_o = 96.00.$$

Changes in the intergenerational income distribution are analyzed within a range of minimum and maximum inequality. Minimum inequality corresponds to the case in which old and young agents are endowed with the same income level,

$$w_y = w_o = 96.$$

Maximum inequality corresponds to

$$w_y = 107.87 \quad \text{and} \quad w_o = 48.54$$

The maximum inequality values correspond to a replacement rate of 45% which the Chilean government committed to guarantee when it signed the International Labor Office's International Agreement 126 of 1967.

5.2.1. *Equilibrium with the Current Institutional Framework*

The first result of considering different distributions of income is that the current institutional framework does not yield a unique equilibrium. The framework's outcome depends on the degree of intergenerational inequality. For low degrees of inequality, the system yields a result similar to the age segmentation currently observed in the Chilean health sector. However, the model predicts that for higher degrees of inequality, the system would resemble a "pure" public system.

For sufficiently unequal distributions, $w_o \in$ (48.54, 64.02), and the corresponding range for $w_y$ given by $w_y = 120 - 0.25w_o$, the model yields an outcome in which both young and old agents choose to insure themselves with the public insurance ($x_y = 1$, $x_o = 1$)[19]. For the rest of the range considered, $w_o \in$ (64.02, 96.00), the equilibrium with the observed age segmentation in the Chilean health sector ($x_y = 0$, $x_o = 1$) holds.

It is interesting to notice that neither conditions 12 nor 10 are ever satisfied in the range of intergenerational inequality considered in this section, which

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[18] Keeping per capita income constant is equivalent to keeping life-time income constant since all agents are identical. For this same reason, what has been called intergenerational income distribution also corresponds to intertemporal distribution of income.

[19] See Appendix.

indicates that the dominant strategy of the elderly is to insure themselves in FONASA. Given the assumptions and the value of the parameters used in this paper, the gains obtained by the elderly (government subsidy and cross-subsidy, in the case in which the young agents also prefer FONASA) outweight the loss of having to purchase a suboptimal amount of health insurance.

The second result of considering different distributions is that within the range of distributions in which the observed age segmentation is the outcome of the model, there is a threshold level of inequality that makes the legal minimum purchase requirement binding for young agents. Indeed, for $w_o < 80$ or, equivalently, $w_y > 100$, $p_y d_y < fw_y$.

In terms of welfare, life-time utility obtained by the representative agent with the current mixed system, $W_M$, for $w_o \in$ (48.54, 64.02) is:

$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau) \tag{15}$$

For $w_o \in$ (64.02, 80.00), $W_M$ is:

$$V_y\left(\left(fw_y, \frac{1-p_y}{p_y} fw_y\right), \tau\right) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) \tag{16}$$

And for $w_o \in$ (80, 96) it is:

$$V_y((p_y d_y, (1-p_y)d_y), \tau) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) \tag{17}$$

5.2.2. *Welfare with Alternative Institutional Arrangements*

The main result of examining the effect of altering the intergenerational distribution of income is the confirmation of the convenience of the current Chilean health sector's institutional framework over the two "pure" alternatives. Within the range of income inequality considered in this paper, the current system yields a life-time expected utility of the representative agent that is at least as high as the one obtained with any of the two "pure" alternatives.

Figure 2 shows life-time expected utility of the representative agent with the current system (CC), with a "pure" public system (FF) and with a "pure" private one (II). Life-time expected utility with the current system is given by equation 15 for $w_o \in$ (48.54, 64.02), equation 16 for $w_o \in$ (64.02, 80.00) and equation 17 for $w_o \in$ (80, 96). Life-time expected utility with a "pure" public system is obtained by substituting the values of the parameters and $w_y = 120 - 0.25 w_o$ into equation 13. The same substitutions in equation 14 yields life-time expected utility in a "pure" private system.

Figure 2 shows that the current mixed system always results in a higher level of life-time expected utility than with a "pure" private system. The gains from the intergenerational redistribution in the current system outweight the losses due to its inefficiencies. This holds even when there is no income inequality ($w_o = w_y = 96$). The higher probability and cost of illness of the elderly

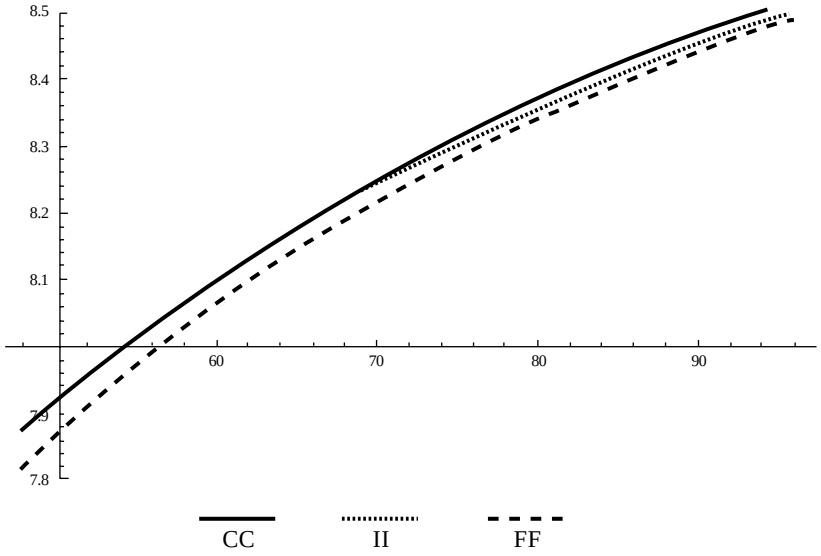
makes the redistributional attribute of the current system desirable in spite of its inefficiencies. In fact, if one compares the "pure" public system with the "pure" private one, it can be seen that the non-income intergenerational differences are large enough to make redistribution with taxes and inefficient cross-subsidies, and legal minimum purchase requirements more convenient than a non-distortionary and non-redistributionary system.

However, Figure 2 also shows that the importance of redistribution and, consequently, the convenience of the current and "pure" public systems over a "pure" private one decreases with equality. Indeed, the distance between II and FF falls as $w_o$ approaches 96. The fact that the welfare gap between the current and the "pure" public system increases as intergenerational income distribution improves is also an indication of the reduced importance of the mechanisms of redistribution or, equivalently, the increased importance of efficiency.

Figure 2 also shows that in the $w_o \in$ (64.02, 96.00) range, where the current system results in age segmentation $x_y = 0$ and $x_o = 1$, life-time expected utility is higher than with a "pure" public one. This occurs because the efficiency cost of maximizing redistribution through a "pure" public system is too high. The current mixed system, which does not sacrifice all of the efficiency attributes of the private insurance system, is more convenient.

In the $w_o \in$ (48.54, 64.02) range, where agents in the current system choose to insure themselves only in FONASA, the current system and the "pure" public one, obviously, result in the same level of expected utility.

FIGURE 2



## 6. A Reform Proposal: Compulsory Savings Account

Having shown that the current mixed system yields a life-time expected utility of the representative agent that is at least as high as the one obtained with any of the two "pure" alternatives does not imply that it can not be improved. In fact, in this section we examine the effect of implementing a reform similar to the one proposed by Fischer, Mizala and Romaguera (1998) and find that the Chilean health system can be improved without altering its mixed nature. The proposed reform is the creation of a compulsory individual savings account to finance, together with the central government allocations and the compulsory 7% payroll deductions, the elderly's health insurance plans. The proposed modification establishes a mechanism which forces agents to transfer income from the first high-expected-utility period to the second low-expected-utility period without restricting free choice. Indeed, if while old agents prefer a health insurance plan or health insurance supplier different from the one they selected while young, they may make the switch and use their accumulated savings to purchase health insurance from their preferred insurance company, which could be either FONASA or any of the ISAPREs.

The modification requires young agents to save *s* pesos in an individual savings account. The account would yield a rate of return *r* and agents would be required to purchase with it health insurance while old. In terms of the model, life-time utility would be

$$W = (1-p_y)U(w_y - \tau - s - \alpha_y) + p_y U(w_y - \tau - s - d_y + \gamma_y) + \beta[(1-p_o)U(w_o - \tau - \alpha_o) + p_o U(w_o - \tau - d_o + \gamma_o)]$$

The minimum purchase requirement and, therefore, the premium charged by FONASA remains the same for young agents, $\alpha_y \geq fw_y$, while for old agents it increases to $\alpha_o \geq fw_o + s(1+r)$. The zero expected profit condition plus the minimum legal requirement imply that the set of private contracts offered by ISAPREs are $[\alpha_y^P \geq fw_y, ((1-p_y)/p_y)\alpha_y^P]$ and $[\alpha_o^P \geq fw_o + s(1+r), ((1-p_o)/p_o)\alpha_o^P]$ where the levels of $\alpha_y^P$ and $\alpha_o^P$ are determined by the purchaser. The benefits offered by FONASA are

$$\gamma_y^F = \gamma_o^F = \frac{\tau + (1-p_y)x_y\mu_y(fw_y + s(1+r)) + (1-p_o)x_o\mu_o(fw_o + s(1+r))}{p_y x_y \mu_y + p_o x_o \mu_o}$$

The analysis is restricted to values of *s* and *r* that imply that the modification would not distort the health insurance decisions of the elderly in the private market. That is,

$$p_o d_o \geq fw_o + s(1+r)$$

This restriction also implies that, with the functional form of preferences and parameter values used to model the Chilean case, the necessary conditions

of the Chilean age segmentation equilibrium ($x_y = 0,\ x_o = 1$) continue to be met after the reform is implemented. This simplifies the analysis and, more importantly, allows us to examine whether the performance of the system can be improved without altering its mixed nature. Indeed, using the parameters and functional specifications of the Chilean case and taking s as given to solve the model, yields the ($x_y = 0$, $x_o = 1$) equilibrium. Expected life-time utility of the representative agent is

$$(18)\quad W = \ln(w_y - \tau - s - p_y d_y) + \beta[(1 - p_o)\ln(w_o - \tau - fw_o) + p_o \ln(w_o - \tau - d_o + \gamma_o^F)]$$

To prove that the establishment of the mandatory individual savings account can improve performance of the health system, we show that, for reasonable values of *r*, the partial derivative of *W* with respect to *s* (valued at $s = 0$, the current pre-reform framework) is greater than zero. Deriving equation 18 with respect to *s* and substituting $\partial\gamma_o^F / \partial s = ((1 - p_o)(1 + r)) / p_o$ yields

$$(19)\qquad \frac{\partial W}{\partial s}\Big|_{s=0} = -\frac{1}{w_y - \tau - p_y d_y} + \frac{\beta(1 - p_o)(1 + r)}{w_o - \tau - d_o + \gamma_o^F}$$

Substitution of the parameter values of the Chilean case in equation 19 yields that $\partial W / \partial s|_{s=0} > 0$ for $r > 0.1019$, which is not an unreasonable condition if one considers the fact that the model's first period lasts approximately 40 years.

## 7. Conclusions

In the paper we developed a formal model of the Chilean health sector. Although the analytical framework was used to analyze the observed age segmentation between the private and the public health insurance, it can also be used to analyze the segmentation based on type of illness.

The model was calibrated, with parameters consistent with the Chilean economy, to replicate the observed age segmentation in which most of the elderly prefer to insure themselves with the public insurance.

Given the institutional framework faced by firms and agents, the outcome of the model is the result of competitive behavior by firms and optimal choices by individuals. Indeed, since there are no barriers to entry nor exit in the private insurance market and contracts are individual and last for only one period, ISAPREs are forced to offer fairly priced plans which necessarily imply that the premiums charged rise when agents grow old. On the other hand, old agents choose to purchase health insurance from FONASA and profit from its subsidized prices. Hence, the model gives support to the broadly accepted diagnosis according to which the observed segmentation is a direct consequence of the design of the Chilean health sector.

Contrary to the claims of many, the resulting age segmentation in the current framework does not necessarily imply that "pure" forms are better. In fact,

the model yields that welfare, measured in terms of the expected lifetime utility of the representative agent, is higher with the mixed system than with either a "pure" private or a "pure" public system. This is due to the fact that, as opposed to a "pure" private system, it is able to redistribute from the young agents to the elderly, and at the same time it does not generate all of the distortions of a "pure" public system.

Although we found that the social value of intertemporal redistribution depends on the value of the discount factor, we nevertheless found that when only plausible values of the parameter are considered, the current mixed system yields the highest level of life-time expected utility.

The model yields two interesting results when intergenerational inequality is incorporated in the analysis. The first one is that the outcome of a given institutional framework depends on the distribution of income. In the particular case of the Chilean health system, for low degrees of inequality the legal and institutional framework will result in a mixed system with the age segmentation currently observed in the Chilean health sector. However, the model predicts that for higher degrees of inequality, the system would resemble a "pure" public system.

The other result is that, for the parameter values of the base scenario, the ranking of the three systems, the current one and the two "pure" alternatives, in terms of the representative agent's life-time expected utility is not affected by the intergenerational distribution of income. Within the range of inequality examined in the paper, the ranking is leaded by the current system, a "pure" public one follows it and the last place is occupied by a "pure" private one.

Although the ranking of the different institutional alternatives is not affected by the degree of inequality, the differences in terms of welfare between the different systems is affected. Indeed, the convenience of the current and the "pure" public system falls, as income distribution becomes more equal. This occurs because the benefits of redistribution decrease and therefore the mechanisms of redistribution in those systems become less valuable.

The paper ended by proposing a modification within the current mixed structure of the Chilean health system: the creation of a mandatory individual savings account to finance the elderly's health insurance. In the last section it was shown that this reform could improve the performance of the Chilean health sector by reducing intergenerational inequality.

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## APPENDIX

For degrees of inequality corresponding to the range $w_o \in (48.54, 64.02)$, and the corresponding range for $w_y$ given by $w_y = 120 - 0.25w_o$, the equilibrium in which all the population chooses to insure themselves in FONASA ($x_y = 1$, $x_o = 1$) holds. Both of its conditions are satisfied:

Condition 5, which states that if while old, individuals choose FONASA then while young they must prefer FONASA's plan to any plan offered by ISAPREs, is satisfied:

$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau) >$$

$$V_y\left(\left(fw_y, \frac{(1-p_y)}{p_y} fw_y\right), \tau\right) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau)^{20}$$

The expression for the contract offered by the ISAPRE to the young individual is $(fw_y,((1-p_y)/p_y)fw_y)$ and not $(p_y d_y, (1-p_y)d_y)$ because for $w_o < 80$ or, equivalently, $w_y > 100$, the legal minimum purchase requirement becomes binding: $p_y d_y < fw_y$.

Condition 6, stating that if while young, individuals choose FONASA then while old they must also prefer FONASA, is also satisfied:

$$V_o((fw_o, \gamma_o^F[1,1]), \tau) > V_o((p_o d_o, (1-p_o)d_o), \tau)^{21}$$

Since the conditions of the other possible equilibria are not satisfied, equilibrium ($x_y = 1$, $x_o = 1$) is unique in the range $w_o \in (48.54, 64.02)$. In particular, conditions 11 and 12 of the equilibrium in which all agents insure themselves privately ($x_y = 0$, $x_o = 0$) are not satisfied for this range[22]. Moreover, condition 12 is never met in the full range of inequality considered in this section ($w_o \in (48.54, 96.00)$).

For degrees of inequality in the range $w_o \in (64.02, 96.00)$, and the corresponding range for $w_y$, the equilibrium with the observed age segmentation in the Chilean health sector ($x_y = 0$, $x_o = 1$) holds:

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[20] Algebraic manipulation and replacement of the assumed functional forms, the base parameter values and $w_y = 120 - 0.25w_o$ in this condition yields:

$$0.28\ln(113.21 - 0.253w_o) + 0.318\ln(0.996w_o - 21.795) >$$
$$0.28\ln(115.87 - 0.295\, w_o) + 0.318\ln(1.13\, w_o - 30.328),$$

which holds for $w_o \in (48.54, 64.02)$.

[21] Replacing the assumed functional forms, the base parameter values and $w_y = 120 - 0.25w_o$ in the above condition simplifies to:

$$0.65\ln(0.93w_o - 0.728) + 0.35\ln(0.996w_o - 21.795) > \ln(w_o - 14.728),$$

which holds for $w_o \in (48.54, 64.02)$.

[22] Explicit reference is made only to this other possible equilibrium since, as was discussed above, equilibrium ($x_y$=1, $x_o$=1 ) excludes the other two possible equilibria.

Condition 8, which states that if while young, individuals prefer private health insurance then it must be the case that they prefer FONASA when they get old, is satisfied:

$$V_o((fw_o, \gamma_o^F[0,1]), \tau) \geq V_o((p_o d_o, (1-p_o)d_o), \tau)^{23}$$

Condition 7, stating that if while old, individuals choose FONASA then while young they must prefer a plan offered by an ISAPRE, is also satisfied. The algebraic expression of this condition depends on whether $w_o < 80$ or $w_o \geq 80$, which, as mentioned above, determines whether the legal minimum binds the young purchaser of private health insurance. In the range $w_o \in$ (64.02, 80.00) condition 7 is:

$$V_y\left(\left(fw_y, \frac{(1-p_y)}{p_y} fw_y\right), \tau\right) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) \geq$$

$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau)^{24}$$

In the range $w_o \in (80,96.00)$ the condition is:

$$V_y((p_y d_y, (1-p_y)p_y d_y), \tau) + \beta V_o((fw_o, \gamma_o^F[0,1]), \tau) \geq$$

$$V_y((fw_y, \gamma_y^F[1,1]), \tau) + \beta V_o((fw_o, \gamma_o^F[1,1]), \tau)^{25}$$

Since in the range of inequality given by $w_o \in$ (64.02, 96.00), the necessary conditions of the other possible equilibria are not satisfied, the equilibrium in which young agents insure themselves privately while old agents affiliate to FONASA ($x_y = 0$, $x_o = 1$) is unique. In particular, condition 10 of the

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23 Replacing the assumed functional forms, the base paremeter values and $w_y = 120 - 0.25w_o$ in this condition yields:

$$0.65\ln(0.93w_o - 0.728) + 0.35\ln(1.13w_o - 30.328) \quad \ln(w_o - 14.728),$$

which holds for $w_o \in$ (64.02, 96).

24 Replacement for the assumed functional forms, the base parameter values and $w_y = 120 - 0.25w_o$ in this condition can be simplified to:

$$0.28\ln(115.87 - 0.295w_o) + 0.318\ln(1.13w_o - 30.328)$$
$$0.28\ln(113.21 - 0.253w_o) + 0.318\ln(0.996w_o - 21.795),$$

which holds for $w_o \in$ (64.02, 80).

25 Manipulation and replacement for the assumed functional forms, the base parameter values and $w_y = 120 - 0.25w_o$ in this condition results in:

$$\ln(112.27 - 0.25w_o) + 0.318\ln(1.13w_o - 30.328)$$
$$0.72\ln(110.87 - 0.232w_o) + 0.28\ln 113.21 - 0.253w_o) + 0.318\ln(0.996w_o - 21.795),$$

which holds for $w_o \in$ (80 , 96).

equilibrium in which young agents prefer FONASA and old agents choose ISAPREs ($x_y = 1$, $x_o = 0$), is not satisfied for this range[26]. Moreover, condition 10 is never met in the full range of inequality considered in this section ($w_o \in$ (48.54, 96.00)).

[26] Explicit reference is made only to this other possible equilibrium since, as was discussed above, equilibrium ($x_y = 0$, $x_o = 1$ ) excludes the other two possible equilibria.