Diagnoses-Based Risk Adjusted Capitation Payments for Improving Solidarity and Efficiency in the Chilean Health Care System: Evaluation and Comparison with a Demographic Model

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vorgelegt von
Name: Camilo Cid Pedraza
aus: Valparaíso, Chile
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Erstgutachter: Prof. Dr. Jürgen Wasem
Zweitgutachter: Prof. Dr. Reinhold Schnabel

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SUMMARY

In Chile health insurance is mandatory for formal sector workers, so that they can be insured against the risks of health care costs. Health coverage is provided by both public (National Health Fund –FONASA) and private sector insurers (Previsional Health Care Institutions – ISAPREs). Workers pay a mandatory contribution of seven percent of their income to ensure coverage with a maximum mandatory monthly contribution of US$ 152. If individuals choose the public sector, their coverage is pre-established, comprehensive and does not vary in time. If instead they choose the private sector, they must also choose how much coverage to purchase and thus the monthly contribution may exceed the mandatory seven percent depending on the benefits of these plans and the health risks of the individuals. In fact, premiums in the private sector have been increasing and in December 2007 it reached an average of 10.7% of income.

Any person has, in theory, the choice to insure with FONASA or with an ISAPRE. They may also change periodically between ISAPREs and FONASA. Both are responsible for directly providing medical care through their own providers or by contracting with third-party providers.

The government partially subsidises the public system's health care expenditure. FONASA classifies its beneficiaries into four income groups, denoted by the letters A (low income) to D (high income within FONASA). With the exception of those insured in group A, all other FONASA affiliates, theoretically, have the option to select public or private providers that hold agreements with FONASA.

The public health care system is decentralized into 28 regional units that cover the entire territory. The National Health Services System manages its population through its hospital network and manages the provision of health goods for the public sector with a historical global budget as their main source of financing. Private provision, on the other hand, operates in a traditional market environment and receives fee-for-service payments.

In 2007, about two-thirds of the population was insured with FONASA (70% or approximately 11.7 million people), 17% with ISAPREs (approximately 2.8 million people) and 13% had other coverage (Armed Forces) or no insurance.

Chile has significant inequities in the health financing between the public and private sectors, and between the high- and low-income groups of the population. The institutional arrangement separates the financing of FONASA and each ISAPRE. On the other hand, there are high co-payments and out-of-pocket expenditures of the population.

It is well known that risk selection leads to inefficiency since it can exclude some people – generally high-risk and low-income people− from the market, leaving them without the desired coverage. It can also generate that certain groups' preferences –for example, high risks− not be considered or that they receive poor quality services or no services at all in an attempt to motivate their exit; and it can eliminate the incentive to reduce costs to the extent that cream skimming is more profitable.

Risk selection can be the result of informational failures as well as regulations. Informational failures result in adverse selection problems, where individuals can hide information about their health status preventing insurers to distinguish and set premiums according to their level of risk, which is a condition for achieving efficiency. Therefore, insurers will use their scarce information to select those with lower risk. On the other hand, if regulation dictates that insurers charge the same rate to all insurees, this also provides incentives for insurers to select the less costly.

In a competitive health insurance market, without proper regulation, the risk premium will be high for the elderly, the sick, women in fertile age, and large families and the risk premium will be low for the young, single, and small families. This is what we currently see in the case of ISAPREs in Chile.

In Chile, as in other countries, risk selection generates many types of inefficiencies. First, ISAPREs do not have the incentive to respond adequately to the needs of high risk affiliates. Second, ISAPREs' success in attracting low-risk individuals generates a segmented market, where low premiums are charged to low-risk individuals and high premiums are charged to high-risk individuals, and no private health insurance plan is designed for consumers with income levels below a certain threshold. This generates a solidarity problem for the social security system. Furthermore, individuals who cannot afford ISAPREs' high premiums end up switching to FONASA and this generates a financial deficit covered with public funds, which leads to an equity problem.

In this context, selection is more profitable for ISAPREs than improving efficiency in the production of health care services. In fact, the more efficient insurance companies, which do less risk selection, run the risk of losing market share. Although a single ISAPRE may gain from selection, it is still a loss for society and hence a total welfare loss. Due to selection problems in the insurance system, the young and rich population and relatively few women are privately insured; the elderly, handicapped or chronically ill, families with more dependents and low-income individuals are insured with FONASA. Of course the mobility between ISAPREs is low and it is limited by age and the existence of pre-existing conditions.

Similar international experience, especially in Europe, focused on the risk selection concern, the removal of beneficiaries, and the inequities that they generate. Europe has taken strong steps towards finding solutions to these problems, beginning with a systematic diagnosis of the situation. We use these tools and relevant concepts to simulate their implementation in the Chilean case.

One way to reduce risk selection is to create premium cross-subsidies from low-risk groups to high-risk groups. This policy makes solidarity subsidies effective, without hindering the competition within the insurance system. This may be done through a risk adjustment model that uses the available information to estimate expected health costs for an individual or group, based on utilization and observed costs, to establish the subsidy for the high-risk group. Risk adjustment is expected to neutralize incentives for risk selection to the extent that insurers become indifferent to who becomes a beneficiary, by compensating for their affiliates costs or risks. Risk adjusted premiums need to cover each individual expected health care expenses in order to eliminate insurer incentives to prefer low-risk individuals. If done correctly, health insurers receive less money for low-risk people and more money for high risk. Nevertheless, the model does not need to predict exactly each individual's probability of being sick with its associated costs, but it has to do it better than insurers. Thus, the costs of cream skimming become larger than its benefits.

We review several risk adjustment models, considering that FONASA is expected to subsidize the poor. We begin by reviewing the model implemented in the reform, which is a cell-model for ISAPREs only and limited to the GES basic package. We then apply the model but include FONASA (this was the original proposal for the reform). In the later simulations we increase the complexity of the model by presenting a regression model that in the first stage uses demographic adjustment and then incorporates diagnoses (morbidity).

Our results show that the model incorporating morbidity is a much better predictor than the previous alternatives. This model recognizes the current and expected morbidity present in FONASA, which has been the recipient of the "bad risks", and therefore redistributes more in favour of FONASA.

So, first, we use the risk adjustment method applied to the Solidarity Compensation Fund only for ISAPREs between 2005 and 2007. We consider all 56 GES health problems and we compute the value of the solidarity contribution as the expected costs by age and sex risk groups of the Fund's beneficiary population and the premium subsidies for each risk group. The results are: four ISAPREs are contributors and the five are recipients of resources, representing 35% and 65% of the beneficiaries, respectively; out of the resources that the Fund collected in 2007, only 1.8%, is redistributed, i.e., 1.8% of the GES average premium and redistribution is quite moderate, at an average annual rate of US$ 0.44 per beneficiary, which represents and 0.076% of the operational income of the private system. Moreover, there is redistribution towards the elderly and children under one, whose expected costs are significantly above average, and towards ISAPREs whose enrolees have relatively high incomes. The latter happens because some ISAPREs have specialized in older, healthy and high-income individuals.

It is important to note that the incentives that come with risk adjustment depend on the amounts involved. As such, the effect the Fund and risk adjustment would have is directly related to the number, utilization and price of the problems incorporated in GES. The most important problem of this system is that this Fund cannot adequately correct the risk selection problems because it does not include FONASA. Basically ISAPREs can still select the good risks and send the bad risks to FONASA, which means that FONASA subsidizes the private system.

In the second model, we use a cell-demographic-model with FONASA under the assumption that the sum of premium contributions of FONASA is US$ 1.07 billion (with an annual solidarity contribution of US$93.56 per capita, more than three times the last model). Of this, US$ 52.8 million is redistributed from the ISAPREs as a result of the greater risk index of FONASA. This transfer is equivalent to 4% of the Fund's resources.

Finally, we basically compare two concurrent risk adjustment regression models based on their ability to predict the current health care costs: the demographic model that predicts costs based only on sex and age; and the diagnosis-based model, which incorporates health conditions grouped as the Hierarchical Condition Category of the Diagnosis Cost Group Classification System (DxCG/HCC). We predict expenditures at the individual level using Ordinary Least Squares (OLS) regression estimates. Based on adjusted-R^2, the demographic model explains only 2.6% of the variance in total actual expenditure. When the model uses morbidity and has an adjusted-R^2 of 36.1%. The predictive performance of this model performs 14 times better than the demographic model. Mean absolute prediction error provided equal ranking, where the recalibrated DxCG/HCC model (with morbidity) was 23% more than the demographic model.

The relative rankings of the models remained unchanged when their concurrent predictive performances for groups of enrolees with relatively high, medium and low expenditure were evaluated. The predictive ratio results for enrolees grouped by quintiles of actual expenditure shows that the demographic model is grossly underpaying the lowest expenditure quintile. The demographic model with a dummy variable for hospitalisation and the diagnosis based model overpay the lowest expenditure quintile and underpay the highest expenditure quintile. The recalibrated DxCG/HCCs model performs even better, though there is still overpayment for the lowest expenditure group of insured and underpayment for the high expenditure groups.

In conclusion, the introduction of risk adjustment is necessary in Chile. The current age/sex based risk adjustment model is inadequate because it considers too few relevant patient characteristics. Additionally, we show that only a small part of the variation in individual resource use is explained. When the model is used for payment, it could encourage favourable selection and causes access problems. Instead the diagnoses-based risk adjustment model can distinguish differences in expected costs concurrently and explain more and better the variation observed in health spending across individuals. In sum, in a scenario with many market failures, as is the case with the health care sector, there is a trade off between equity and efficiency, which is a key challenge faced by governments and technical regulatory institutions. The redistribution of risks from the young to the elderly, and from the healthy to the sick, may improve both equity and efficiency in the system. Furthermore, as our results show, the higher the quality of the risk adjustment model, the smaller the trade off between equity and efficiency. Finally, we offer policy recommendations that address the problems identified directly as well as complementary policies. The suggested policies include maintaining the seven percent of income contribution but making it cover a benefits package that is equivalent to this contribution (i.e. more comprehensive than GES). These income-based contributions would go into a single national fund which to be redistributed through a diagnoses-based risk adjustment model in capitated payments.

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ACRONYMS

ACC	Aggregated Condition Category of DCG Model
AUGE	Universal Access with Explicit Guarantees (*Acceso Universal con Garantías Explícitas*) − Benefits Package of the Chilean Health Care Reform
CASEN	National Household Survey (*Encuesta de Caracterización Socioeconómica Nacional*)
Ch$	Pesos Chilenos (Chilean Currency). Ch$697 = 1 Euro (Dec. 2006); Ch$727 = 1 Euro (Dec. 2007)
DCG/HCC	Hierarchical Condition Category of DCGs
DCGs	Diagnostic Cost Groups
DRGs	Diagnostic Related Groups
FONASA	National Fund of Health (*Fondo Nacional de Salud*). Public Health Insurer
GES	Explicit Health Guarantees (*Garantías Explíticas de Salud*) − synonymous to AUGE
HCC	Hierarchical Condition Category
ICD	International Codification of Diseases by the World Health Organization
INE	National Institute of Statistics (*Instituto Nacional de Estadísticas*)
ISAPREs	Health Insurance Institution (*Instituciones de Salud Previsional*) − private health insurers
MAI	Modality of Institutional Health Care (*Modalidad de Atención Institucional*) − FONASA's health care service provision in public networks of health care
MIDEPLAN	Ministry of Planning of Chile (*Ministerio de Planificación*)
MINSAL	Ministry of Health in Chile
MLE	Free Choice Modality (*Modalidad de Libre Elección*) − FONASA's health care services chosen by beneficiaries between public or private providers that have a contract with FONASA
PAD	Diagnosis Related Payment (*Pago Asociado a Diagnóstico*) −A payment system of FONASA
PIPDCGs	Principal Inpatient Diagnostic Cost Groups
PPP	Fee-for-service (*Pago por Prestación*) − A payment system from FONASA to public providers
RUT	National identification in Chile
SCF	Solidarity Compensation Fund
SHI	Social Health Insurance
US$	U.S. dollars

I. INTRODUCTION

Chile's mixed health insurance system with private and public insurers is inefficient and inequitable, as has been shown in several studies reviewed in this research. In general terms, individuals pay a fixed health premium to public or private insurers based on income. Public insurers have open enrolment, meaning anyone can join. Private insurers do not have open enrolment, giving them incentives to select affiliates by risk. This practice has created an inequitable and inefficient system that overburdens the public sector with high risk individuals.

The international experience has shown that risk selection can be addressed by using risk adjustment methods for financing in order to improve both efficiency and equity. The main goal of this research is to assess these problems in Chile, identify their causes, and simulate financing risk adjustment.

We begin this introduction by describing the Chilean health sector and the most recent health reform (July 2005 to date). Then, we present a brief overview and the structure of this document.

1. The Chilean health care system

In Chile health insurance is mandatory for formal sector workers, so that they can be insured against the risks of health care costs. Health coverage is provided by both the public and private sectors. Formal sector workers pay a mandatory contribution of seven percent of his or her income (up to US$ 2,175) to ensure coverage, making the maximum monthly contribution for health insurance US$ 152.[1] If individuals choose the public sector, their coverage is pre-established, broad and does not vary in time. If instead they choose the private sector, they must also choose how much coverage to purchase and thus the monthly contribution may exceed 7% depending on the benefits of these plans and the health risks of the individuals. Furthermore, premiums for private health insurance have been increasing. In 2002 the average contribution by

[1] As of December 2007.

those with private health insurance was 9.2% of the income of contributors. In 2004 it was 9.4%, 9.8% in 2005 (Superintendence of Health, 2007) and in December 2007 it was 10.7%.[2] Therefore, ISAPREs have an income- and risk-related premium that amounts to 7% or more of income, while FONASA only uses an income-related premium which is 7% of income.

Any person has, in theory, the choice to insure with the public insurer (National Health Fund – FONASA) or with one of the fourteen[3] private insurance companies[4] (Private Health Care Institutions – ISAPREs). They may also change periodically between private insurers and FONASA. Both ISAPREs and FONASA are responsible for directly providing medical care through their own providers or contracting with third-party providers to provide care to their beneficiaries.

In 2007, about two-thirds of the population was insured with FONASA (70% or approximately 11.7 million people), 17% with one of the ISAPREs (approximately 2.8 million people) and 13% had other coverage (Armed Forces) or no insurance.[5] Due to selection problems in the insurance system, the young and rich population and relatively few women are privately insured; the elderly, handicapped or chronically ill, families with more dependents[6] and low income individuals are generally insured with FONASA.

The government partially subsidises the public system's health care expenditure. FONASA classifies its beneficiaries by income groups, denoted by the letters A (poorest) to D (richest).

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[2] Source: Author calculations with Superintendence of Health data.

[3] There are two types of ISAPREs: open ISAPREs and closed ISAPREs. Open ISAPREs are open for all, while closed ISAPREs are associated with personnel of a company or of a specific production sector. For example, workers of the national copper industry have their exclusive ISAPRE (ISAPRE Fusat). This distinction is an important one because, by law, risk adjustment includes only the open private insurers. In April 2008, there were 14 ISAPREs, 8 of which were open and 6 were closed (Superintendence of Health, April 2008). But in July of 2005, there were 16 ISAPREs, of which 8 were open and 8 were closed.

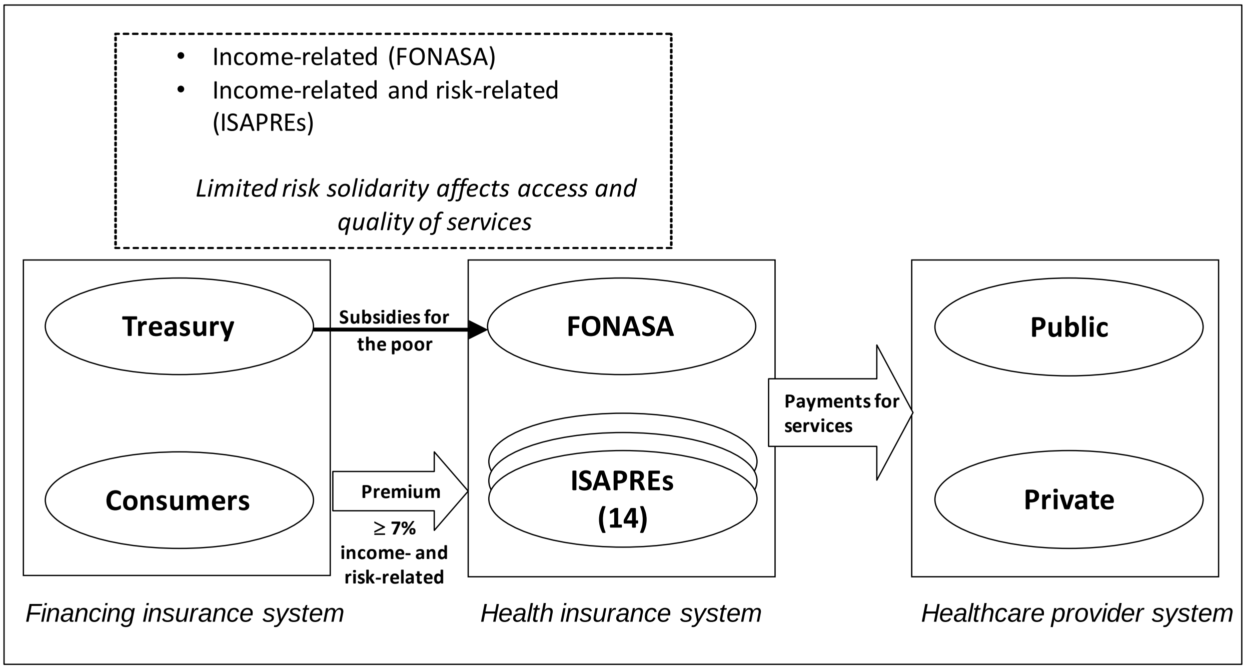
[4] We show that the unregulated system creates a series of problems that limit the freedom of choice. Among the more relevant problems is the cream skimming in the private sector that overburdens the public system.

[5] This information is for 2005, MINSAL (Ministry of Health), FONASA and Superintendence of Health. Sources: http://www.fonasa.cl; http://www.supersalud.cl.

[6] Dependents are family members or others related to the contributor that are not contributing directly but that depend on the contributor.

With the exception of those insured in group A, who are exempt from the payroll tax and all co-payments,[7] all other FONASA affiliates, theoretically, have the option to select public or private providers that hold agreements with FONASA. The public provision includes services rendered by primary health care facilities and public hospitals.

Figure 1: The Chilean health care system



Source: Author's analysis, 2008.

In Chile, public and private health care providers are very different. The public health care system is decentralized into 28 regional units that cover the entire territory. The National Health Services System manages an assigned population through its hospital network and manages the provision of health goods for the public sector. Notwithstanding that primary health care is public and to a large extent dependent on municipal governments, it is the National Health Service's technical relation and health objectives that prevail. Throughout the country, primary care is provided by municipal health care centres following strategies based both on health care teams and family care. Private provision, on the other hand, functions in a traditional market

[7] In FONASA co-payments are regulated with a maximum of 20% of the FONASA price.

environment. Most inpatient care is provided by the public sector, whereas ambulatory care is provided by both systems, except primary care which is provided only by the public sector.

It has been shown that within the Chilean health care system there are deep rooted inequities and a lack of solidarity. These differences can be clearly seen by comparing the public and private system, as well as comparing community groups (age, sex, income, education level, region, county, ethnic background, etc.). Differences also resonate in per capita resource availability, access, opportunity and health care quality, family income, and environmental circumstances, among others. These disparities contribute to the health status inequalities seen in the Chilean population, observed in national indicators, such as general and infant mortality, Disability Adjusted Life Years (DALY's) and life expectancy, among others. These indicators are also closely linked to levels of education, income and employment (Vega, 2001; Vega et al., 2003; Subramanian et al., 2003; Jadue et al., 2004; MINSAL 2002; MINSAL 2005; Olivares, 2006; Cid et al., 2006; MINSAL, 1997).

2. The health care reform

In June 2002 the Government of Chile presented to Congress the legal framework for a health reform. We present the main characteristics of the reform proposal in this section (Ministry of Health, 2002).[8]

2.1. Values and principles that motivated the reform

The following values and principles motivated the reform in Chile:

i. *The right to health:* should be understood as the legitimate right of any person residing within the national territory to have access to health care when needed. This implies the establishment of explicit access, opportunity, quality, and financial protection guarantees, in addition to the generation of resources for effective implementation.

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[8] Introduction of the President of the Republic to white paper of Guarantees in Health, Message N°1-347, MINSAL, Chilean Parliament, Santiago, May 22nd of 2002.

ii. *Equal health as a moral imperative*: relates to reducing avoidable and unfair inequities, granting improved levels of social protection and access to universal care;

iii. *Solidarity in health*: should be understood as the intent of society to provide solidarity to the underprivileged and equal guarantees available to the privileged and underprivileged. This implies that the healthy conform to the ill, men to women, the young to the elderly and the rich to the poor;

iv. *Efficient use of resources*: should be understood as a necessary condition to materialize values such as equality and solidarity in health, and a programmed investment increase in the health care sector. This should result in increased quality and quantity of care, improved medical care and customer service, and implies an effort on behalf of society and service providers; and,

v. *Social participation in health*: to conceive initiatives and evaluate policies and programs.

2.2. The reform proposals considered in this work

The following components of the reform proposals are key for our research. We describe the most important aspects of the reform proposals below.

First, the mandatory and universal standard benefits package currently known as "*Garantías Explícitas en Salud*," (Explicit Health Guarantees or GES) was established.[9] GES guarantees predetermined levels of access, opportunity and financial coverage for ambulatory care, inpatient care and emergency care, for 56 prioritised health conditions. Second, the proposal included the creation of a Solidarity Compensation Fund (Fund hereon after) among public and private insurers[10]. This Fund would finance the benefits package, in order to spread risk, reduce selection incentives (cream-skimming, in particular) and introduce more solidarity into the system. Finally

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[9] GES was originally known as "*Acceso Universal con Garantías Explícitas"* (Universal Access with Explicit Guarantees or AUGE), but was later renamed GES.

[10] This part of the proposal, the Solidarity Compensation Fund, which pooled ISAPREs and FONASA, did not pass congress and was modified to include only ISAPREs

it increases regulation of the private health system and gives more authority to the regulatory and enforcement agency, the Superintendence of Health.

A key instrument of the reform was the Fund. The purpose of the Fund was to compensate health insurers, public and private, for the enrolment of high-risk individuals, based on a model of risk-adjusted premium subsidies that included, at least, age and sex as adjusters.

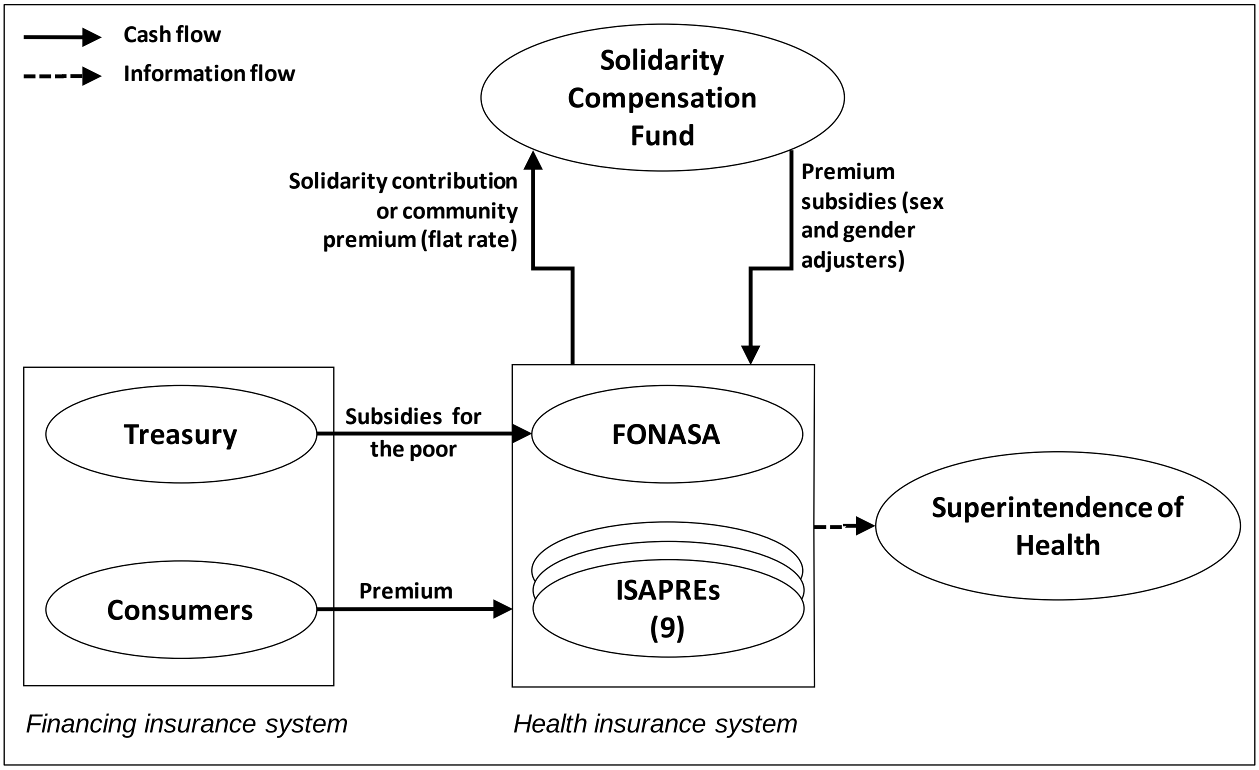
The Reform Commission of the Ministry of Health (2002) decided in 2003 that the Fund would be established for GES's financing. In principle, the Fund would: 1) cover all beneficiaries with the mandatory health insurance (with both FONASA and ISAPREs), including contributors, dependents or indigents; 2) receive a flat rate community premium or solidarity contribution (called "universal premium") from all beneficiaries, computed as the medium cost of the GES package in the public sector; 3) determine the distribution of resources according to the risk profile of beneficiaries of each insurer; and 4) be administered by the new Superintendence of Health.

The Legal proposal established guidelines for the operation of the Fund. For example, the Government would contribute a fixed amount of funding to FONASA, equivalent to the flat rate solidarity contribution, for each indigent person registered in the system[11] (Group "A" beneficiaries of FONASA). Each insurer would pay the Fund a Universal Premium, a fixed amount per beneficiary, established by competent authorities, regardless of individual income or health risk. The Fund would be distributed among insurers in accordance with the health risk structure of their beneficiaries, and every month, insurers would make transfers indicated by the Fund's administrator. Hence, insurers would have to provide the administrator with this information. The regulation that determines the procedures to establish the Health Guarantees Regime considered the use of actuarial calculations in order to set the cost −known as the Universal Premium (solidarity contribution)− and the risk compensation table (of expected costs

[11] Legal initiatives consider a Solidarity Compensation Fund comprised of an amount equivalent to that of the Universal Premium for each beneficiary. For those "lacking resources" or "indigent", the government will provide a subsidy directly to FONASA, until the medium cost is reached.

by age and sex). The authority would entrust the above-mentioned calculations to competent entities.

Figure 2: Cash and information flows of the proposed Solidarity Compensation Fund



Note: In 2003 the ISAPRE system had 16 ISAPREs, and in 2007 there were 14 ISAPREs.
Source: Author's analysis based on the Law Proposal Guidelines (2003)

The Government's proposal with regard to the Fund faced strong opposition from interest groups in the private insurance industry and the political right wing, and was not approved in the parliament. What actually became law differs significantly from this proposal.

The Fund that became law only includes open private insurance companies[12] (open ISAPREs) and it excludes FONASA (Figure 3). The Fund does not actually make or receive monetary transfers, but rather the Superintendence determines net transfers and then notifies "contributing ISAPREs" to compensate "receiving ISAPREs." The Fund is tied to the GES, in the sense that

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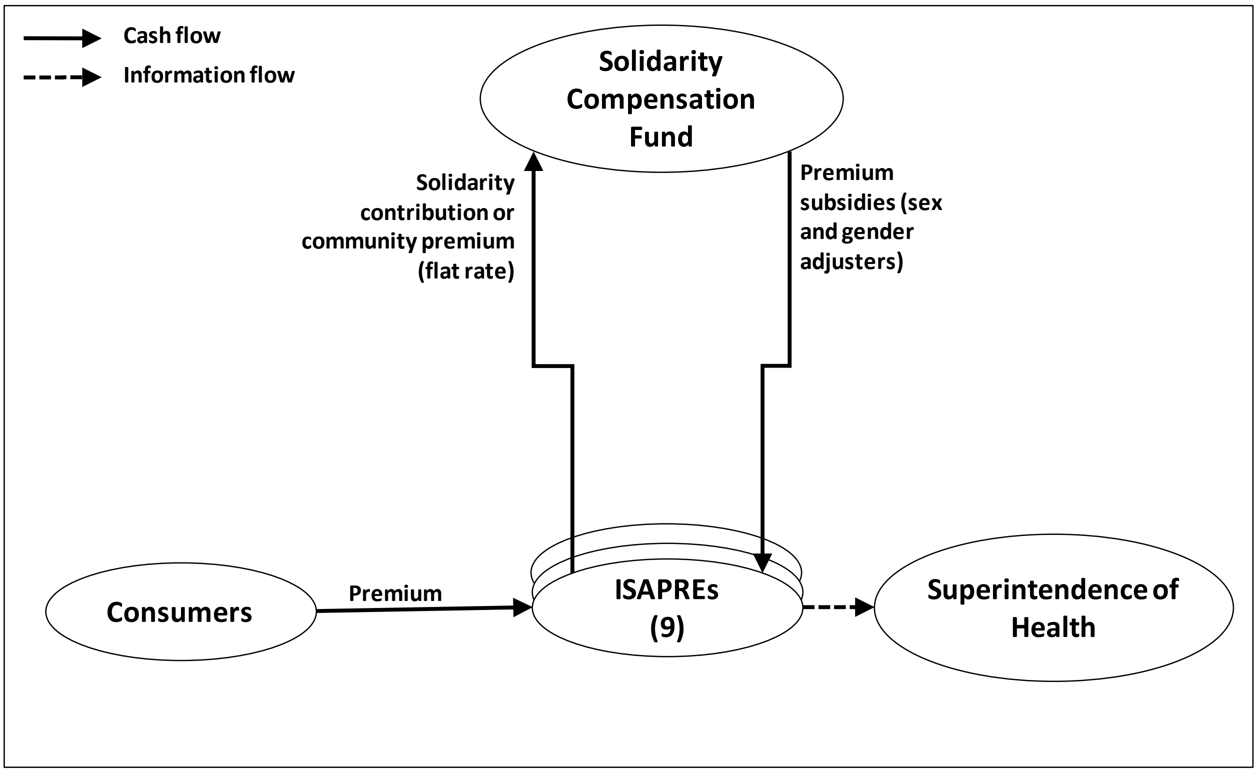
[12] The Law stipulates that the Fund is applicable to all open ISAPREs, except those with a portfolio which is mainly composed of workers and ex-workers of the company which constituted the ISAPRE (closed ISAPREs), for example the ISAPREs associated to CODELCO (Copper National Company) are closed ISAPREs.

each time the GES is expanded to include additional health problems, the Fund also incorporates the additional health problems when calculating the transfers between ISAPREs.[13] So, between July 2005and June 2006, 25 health problems were included in the GES package; between July 2006 and June 2007 another 15 health problems were included; and finally, by July 2007 there were a total of 56 health problems in GES.

Figure 3: Cash and information flows in the approved Solidarity Compensation Fund among ISAPREs



* From July 2005, when the Inter-ISAPRE risk adjustment system was implemented, to December 2007, one open ISAPRE exited the market.
Source: Author's analysis based on MINSAL, 2005.

In summary, the reform included a basic benefits package to be offered by all ISAPREs at a single price to all its beneficiaries. Also, this is another reason to risk adjust the cost of the benefits package. This was done to reduce risk selection incentives.

All ISAPREs established a health provider network for their beneficiaries to receive GES guarantees (GES network) through signed agreements with health providers. ISAPREs have to

[13] One of president Bachelet's promises included increasing the number of health problems to 80 before 2010.

inform their beneficiaries whether health problems are included in GES and with which health providers they can seek care under GES. The beneficiary has the choice of seeking care at his/her ISAPRE's GES network or at the other providers included in his/her health plan, although he/she would lose GES's guarantees, in particular, the financial protection guarantee, if using a non-GES network provider.

This is a general overview of the reform's characteristics that we use in this study. Further clarifications are presented as needed below.

3. An overview and thesis' structure

Our main goal is to study the inefficiencies and inequities in the system and to propose a feasible solution to these problems. To achieve greater solidarity in the Chilean health care system we propose the implementation of risk-adjusted premium subsidies or risk equalization across risk groups, along with adequate regulation. We show that the financial gains of the insurers − achieved through risk selection− represent a social loss for the system. Our results show that if the capitation payment system adjusts using refined adjusters to make them as accurate as possible in predicting medical expenditures, these gains for insurers can be reduced and incentives for risk selection can be lessened significantly. Furthermore, past experience has shown that it is not enough to use demographic variables to determine risk adjustment since it can result in inefficiency and inequity; hence, a more sophisticated model has to be proposed.

We simulate models with two types of Solidarity Compensation Funds: the Fund as approved by the Chilean Parliament (Inter-ISAPREs); and a universal Fund as proposed by the government (which includes FONASA). We compare these two types of set-ups and simulate the demographic risk adjustment proposed by the government with the one that was finally approved by law. Then we simulate an alternative model, that incorporates health status adjusters and econometric analysis, which is the model we propose as more suitable for Chile.

The second chapter is a review of the relevant theoretical framework of risk adjustment for Chile in the light of international experience, mainly in Europe. The international examples presented here reflect the experience until 2007, so more recent developments are not captured.

The third chapter contains an evaluation of the current social health insurance system in Chile. We review both the public and private sectors. We show that private insurers perform risk selection that generates inefficiencies and inequities, and considerable social loss.

Chapter IV contains a detailed description of two risk adjustment models: the model currently being used and the model as originally proposed by the government. The first model is a cell model with demographic risk adjustment and with a Fund only for ISAPREs, as specified by law, which is identical to the one operating in Chile since mid-2005. The second risk adjustment model is also a cell model with demographic risk adjustment but with a Fund for both ISAPREs and FONASA.

In Chapter V, we describe and assess the data and methods for the regression models. Note that risk adjustment models can be prospective or concurrent and the computations may be made using cell or regression methods. Prospective regression methods use only diagnostic information from a past period or periods, to then apply it to the next year. Retrospective methods use diagnostic information from the current period, to then apply it to the current year.[14] The main criterion for judging the value of both models is the amount of variance in spending they are able to explain. A retrospective adjuster will explain more variance in actual spending than a prospective adjuster because it also explains some random variation (Newhouse, 1999). Given the characteristics of the available data set for Chile, we use a concurrent model.

Table 1 shows a summary of the models presented in Chapters IV and V.

[14] Here "retrospective" is the same as "concurrent."

Table 1: Risk adjustment models simulated

Cell models	
Risk adjusters	**Health insurers**
Age and sex	ISAPREs
Age and sex	ISAPREs and FONASA
Regression models	
Risk adjusters	**Health insurers**
Age and sex	ISAPREs and FONASA
Age, sex, and hospitalisation	ISAPREs and FONASA
Age, sex, and morbidity	ISAPREs and FONASA

Source: Authors.

Chapter VI presents the results of the concurrent regression model which incorporates clinical diagnosis for the entire health social security system (public and private) in risk adjustment. We compare this model with the demographic regression model. The demographic model predicts costs based only on sex and age. The diagnosis-based model incorporates health conditions, grouped according to the Hierarchical Condition Category of Diagnosis Cost Group classification System (DxCG/HCC). We compare them based on their ability to predict current costs.

We estimate an Ordinary Least Squares (OLS) regression to predict expenditures at the individual level and to combine the expenses associated with diagnostic groupings (HCCs) and age/sex cohorts. The risk weight reflects an estimate of the marginal cost for a given medical condition relative to the base cost for individuals with no medical conditions. We measure the individual-level predictive performance using individual R-squared (R^2) and the mean absolute prediction error (MAPE). We assess group-level predictive performance using predictive ratios (PR) of expenditure quintiles.

Finally, Chapter VII presents conclusions and discussion. The conclusion of the comparison between the diagnoses-based model and the demographic model is that the diagnoses-based model is feasible and significantly better than the demographic model. It results in greater equity and efficiency improvements.

We also show that the incentives for risk selection within insurers can be reduced through adjusted capitation payment systems. In fact, the more refined the adjusters are, the more accurate the predictions of medical expenditures, which generates less incentives for risk selection.

Furthermore, we also study the feasibility of the application of diagnoses-based risk adjustment models in Chile. We conclude that with political will this type of risk adjustment may be implemented in Chile in the near future.

In sum, this study proposes a feasible risk adjustment model for the Chilean health care system using information that is already available. The model predicts health care costs of individuals from the public and private insurance systems, based on the utilization and observed costs in a fixed time interval, and then adjusts by risk to establish premium subsidies for high-risk groups, to improve efficiency and equity.

II. Theoretical framework of risk adjustment and the Chilean case

1. Theoretical framework

Health care goods or services are characterized by two fundamental features that distinguish them from other goods. On one hand, the demand for health care goods is, to a great extent, a random phenomenon and, on the other hand, it changes immensely depending on the type of individual −or group of individuals− demanding them. There is consensus in the literature that insurance systems are best in this scenario: insurance systems pool resources which in turn can diminish financial risk and improve efficiency and social justice among individuals with health care needs (Arrow, 1963). However, there is also consensus that insurance models, if not properly regulated, do not generate the desired outcomes, particularly in terms of efficiency (Rothschild and Stiglitz 1976). The market fails because the consumer is unable to make rational decisions about his or her demand for health services. The market also fails because health goods exhibit collective good properties which give rise to externalities and the "free rider" problem (Arrow, 1963; Zweifel and Breyer, 1997).

Moreover, risk of illness is heterogeneous and not observable to the insurer, causing adverse selection. In a competitive insurance market we expect implicit premium cross-subsidies −from low risks to high risks.[15] This cross-subsidy is not sustainable in the case of health insurance because competition minimizes the predictable earnings in every contract (van de Ven et al., 2001). Health insurers have to break even through premium differentiation or risk selection.

Insurers adjust premiums by expected risk to avoid losses and to break even, known as premium differentiation. Alternatively, insurers may adjust the acceptable expected risk of the premium, which is reported in the literature as risk selection (van de Ven et al., 2001; Newhouse, 1999). Therefore, risk selection is a set of actions by insurers to exploit unpriced risk heterogeneity and

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[15] By high- and low-risk consumers we mean those consumers for whom the ISAPREs or any other health insurances expect predictable losses or profits, respectively, given the risk groups for calculating the premium subsidies and given the restrictions on the variation of the premium contributions (van de Ven et al, 2001)

to break pooling arrangements. In Chile, ISAPREs determine the level of insurance offered to each individual depending on the premium received by the insurer, which is equal to the income- and risk-related premium contribution (7%) plus an additional risk-adjusted premium (Puig, 1999).

In a scenario with different risk groups and no basic benefits package (insurance schemes or health plans), competitive markets result in many risk-adjusted premiums and an array of different benefits packages offered by insurers. This occurred in the ISAPRE system in Chile from 1981 until December 2007. As the number of insurance schemes increases it becomes more difficult for the consumer to choose a scheme. The prices of these premiums also vary depending on the insurer's ability to identify risks. The extreme case would be an individual-specific premium (perfect price discrimination). An example of this phenomenon is the 2005 Chilean ISAPRE system, where ISAPREs offered at least 40,000 different health plans (Superintendence of Health, 2005 and 2007). This is equivalent to a rate of 32 insurance schemes per 1,000 contributors.[16]

Under competitive markets, health insurance premiums differ according to risk. Hence, premiums are higher for the elderly, sick, women of fertile age and large families; and lower for young men, unmarried men and small families. However, society can legitimately decide that this situation is not acceptable or desirable. Examples of these arguments include: equity in health and health care, redistribution, social solidarity, etc. As such, it would make sense to introduce a compulsory insurance with a regulated premium. The regulated premium could be the same for all and be independent of individuals' health status, the number of persons in the family (dependents), income and risks of becoming ill. In fact, this was the main argument used in Chile to set premiums at 7% of income, as in many other countries with compulsory social health insurance systems.

However, restricting premiums by linking them to income −with the intent of achieving progressive premiums− generates incentives for risk selection.

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[16] In December 2005, there were 1,244,859 ISAPRE contributors with 1,415,479 dependents, for a total of 2,660,338 ISAPRE beneficiaries.

Income-based premiums make it harder for the insurer to know enrolees' (or groups of enrolees) expected costs. Insurers have the incentive to select their enrolees based on their risk, preferring low- over high-risk individuals. In Chile, insurers are allowed to risk select and to differentiate premiums for individuals to fit their expected risk.

Risk selection has several inefficiencies. For example, insurers can risk select by not responding to the high-risk individuals' preferences. ISAPREs may provide poor service to the chronically ill and choose not to contract with providers who have the best reputations for treating chronic illnesses as a means to discourage their affiliation. This, in turn, can discourage physicians and hospitals from acquiring such a reputation. In sum, as a result of risk selection, high-risk patients may either receive poor care or poor services.

The insurers' success in attracting low-risk beneficiaries leads to a segmented market, where low-risk individuals use one system and high-risk individuals use another system. Insurers charge low premiums to these low-risk members and high premiums to high-risk individuals. This generates not only an efficiency problem but also a lack of social solidarity in a social health insurance system (van de Ven & Ellis, 2000). Finally, risk selection increases transaction costs as a result of the efforts to attract good risks.

In Chile, important groups –poor, elderly, women and newborns− are affected by risk selection and cream skimming.[17] Those unable to pay the high premiums in the private system go to the public system, which has lower premiums; as such, FONASA ends up having a greater proportion of elderly and poor relative to ISAPREs. The final economic effect for FONASA is a funding deficit. FONASA receives less funding from contributions and spends more on health care. FONASA may cover this deficit with its pool of premium payments or with general tax transfers, which implies an equity problem. Old FONASA beneficiaries see the resources available for them diminished by the affiliation of high-risk individuals. Yet, ISAPRE beneficiaries who have higher incomes and pay more taxes than FONASA beneficiaries (with

[17] Cream skimming is a pejorative term used to describe when insurers provide a health service only to the high-value or low-cost customers. It is considered a type of moral hazard. In Chile, cream skimming is observed in parallel to risk selection among ISAPREs.

lower incomes) subsidize FONASA beneficiaries through general taxes. But, Chile's tax structure is regressive (ECLAC, 2008).[18] Furthermore, only approximately 50% of FONASA's budget is financed through general taxes (FONASA, 2005).

Third, when selection is generalized in the system and is beneficial for insurers, it becomes more profitable to select than to improve the efficiency in the production of health care (Wasem, 2002). In the short term, insurers prefer investing available resources on improving risk selection and not on reducing costs, and therefore, they do not improve efficiency. The most efficient insurers that do less risk selection may lose market share with respect to the most inefficient insurers. This results in a loss of resources for society. Risk selection plays against efficiency and, although individual insurance companies may obtain some benefits from risk selection, society as a whole loses.

In this context, it becomes socially desirable to avoid risk selection and to increase solidarity. One mechanism to increase solidarity is risk adjusted premium subsidies. These are subsidies from low- to high-risk individuals (Ellis et al., 2002). This requires a solidarity fund between insurers and a risk adjustment model which uses actual expenditures −based on utilization and observed costs during a fixed period of time− to estimate expected costs in health care of individuals or groups of individuals and then to establish subsidies for high risk groups of individuals (van de Ven and Ellis, 2000). Because risk adjustment pays insurers more for high-risk individuals and less for low-risk individuals, it reduces the risk selection incentives in the market.

There are a number of other mechanisms that reduce risk selection incentives, of which the most important is open enrolment. Open enrolment allows individuals to switch insurers and each insurer is in turn obliged to accept all applicants, subject to the usual conditions –for example, geographical working area, minimum contract period with the current health insurance, prior notification period and others procedural issues (van de Ven, et al., 2001). Although open enrolment by itself does not control risk selection, it is a very important complementary policy

[18] ECLAC's study shows that the Gini coefficient for income of various countries increases or decreases after taxes. In the case of Chile, the after income Gini coefficient increases significantly.

and its inclusion helps prevent insurers from discriminating on the basis of health status. Germany, Israel, the Netherlands and Switzerland have open enrolment policies (van de Ven et al., 2001, van de Ven et al., 2007). In Chile, only FONASA has open enrolment, which is sustainable only because the government provides a supply subsidy to public health providers through FONASA. Without the existence of open enrolment for ISAPREs, risk adjustment becomes even more critical.

In imperfect markets, as is the case with health care, there is a complex trade-off between equity and efficiency. For example, Chile set its mandatory premium payment unrelated to health status (reflecting an equity concern), but this resulted in risk selection (efficiency loss). Risk adjustment in financing reduces this trade-off. The redistribution from low- to high-risk groups, from young to old and from the healthy to the ill improves equity and even efficiency (van de Ven et al., 2001).

2. Risk adjustment models[19]

Risk adjustment models are based on three key elements:

a) Estimation of community premium or solidarity contribution;

b) Expected costs by risks groups; and

c) Premium subsidies to calculate the capitated payments for each individual.

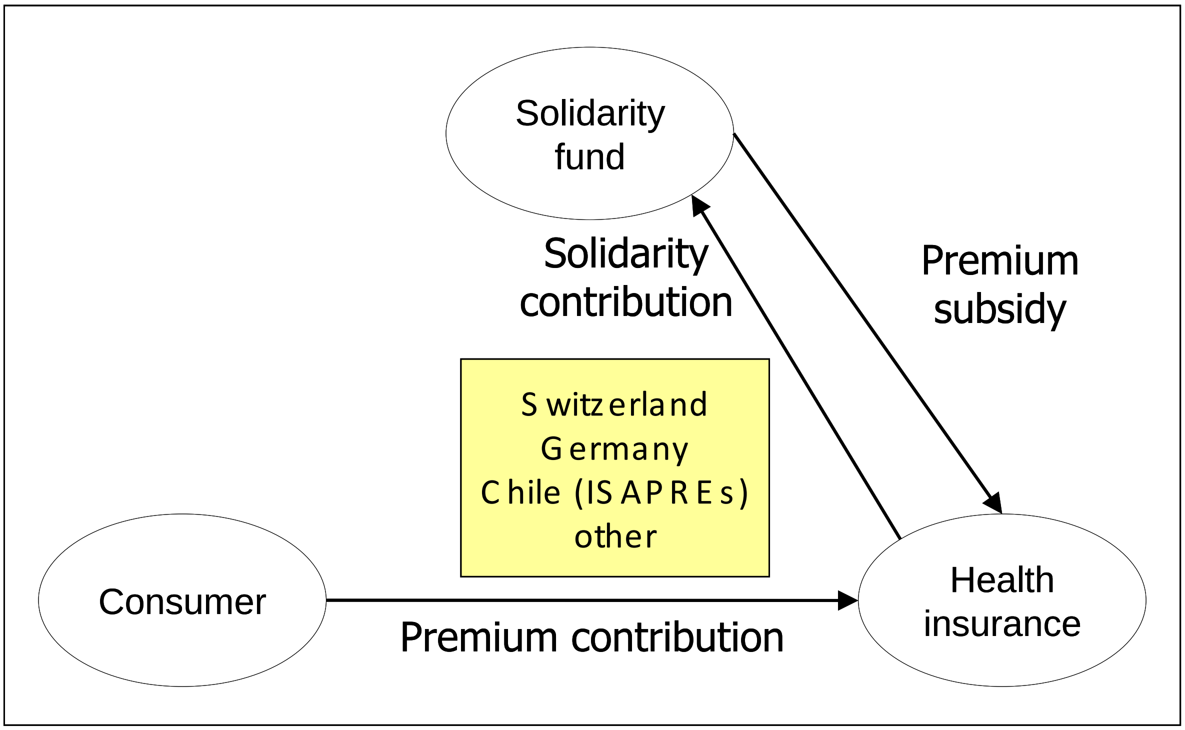
The risk pooling mechanism is commonly known as Equalization Risk Fund or Solidarity Fund. The following sections describe these and other characteristics of risk adjustment models.

[19] The international examples presented here reflect experiences until December 2007, and therefore any more recent developments are not captured.

2.1. Financial flows organization: “external” and “internal” systems

Risk adjustment models may have either “external” or “internal” financial flows. The internal system is when users pay their premiums to insurers and then the insurer pays the community premium to the Solidarity Fund (Figure 4). In the external system users pay premiums directly to the Solidarity Fund (Figure 5) (van de Ven et al., 2001).

Figure 4: Internal organization of cash flows



Source: Adapted from Wasem and Greβ, 2005.

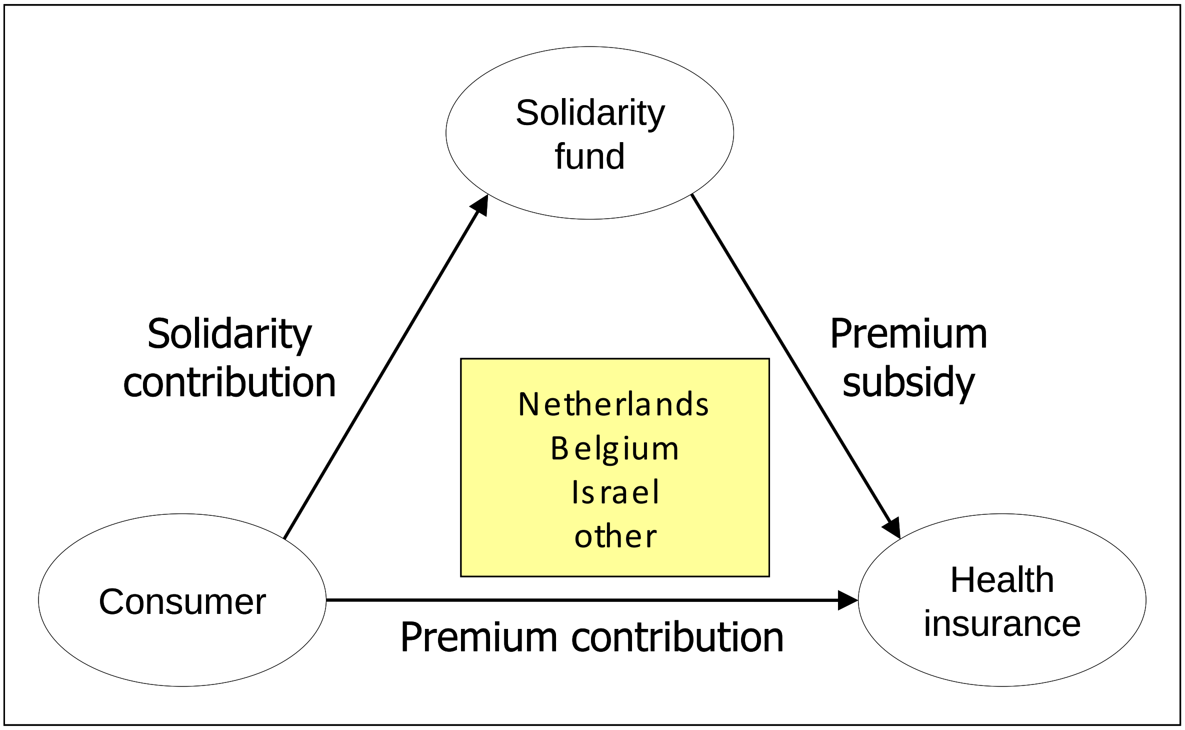
In Chile, the ISAPREs’ risk adjustment is an internal system as in Germany (until December 2007) and Switzerland (van de Ven et al., 2001). The internal system implies lower transaction costs because it uses an existing structure of financial flows and financing. Also, Chile already has a mandatory health contribution and there are norms that prohibit the Superintendence from accumulating resources (Superintendence of Health, 2006), which would be required in an external system.

Countries like the Netherlands (Lamers et al., 2003), Belgium (Schokkaert et al., 2003) and some Eastern European countries (Ellis, 2003) use the external model. This model separates the solidarity contribution to the Solidarity Fund from the premium paid to insurers. By making the solidarity contribution income-related, these countries avoid the distortions generated in competitive markets. The Solidarity Fund then pays insurers the risk adjusted premium subsidies.

For example, in the Netherlands the costs of health insurance are covered by consumers through nominal and income-related premiums.[20] Insurers may set their own nominal premiums but they must be the same for everyone who chooses the same insurance agreement ("in kind" or "reimbursement"). Besides nominal premiums, health insurance is also financed by levying an income-related premium payable by person. These contributions cover 50% of the macro premium burden. The income-related premiums and the amounts provided by the Government are paid into a fund called the Health Insurance Fund (The Ministry of Health, Welfare and Sport, 2005).

[20] There are children's premiums and other state disbursements covered by public funding.

Figure 5: External organization of cash flows



Source: J. Wasem, S. Greβ, 2005.

In any case, it is important to bear in mind that these are operational differences do not alter the main functioning of any risk adjustment model.

2.2. Community premium in the risk adjustment mechanism

The community premium (also referred to as the solidarity contribution) to the Solidarity Fund may be determined in different ways. The essential requirement is that it be independent of the enrolees' health risks. We discuss two methods below: the income-related and the flat rate.

2.2.1 Income-related contribution

An income-related community premium is simply a percentage of income. The percentage of income is computed such that the average premium paid is equivalent to the average cost of the benefits package. For example, Germany uses an income-based risk adjustment model (Buchner and Wasem, 2001, 2003).

This is usually a progressive alternative, although the progressiveness of the adjustment depends on how progressive its financing is. For example, if the fund is financed externally from public revenues and the tax system is progressive, then the income-related premium will be even more progressive. In fact, Wagstaff (2007) suggests that each resource collection mechanism must also take into account its impact on the labour market (tax or social contributions or combinations of these). For example, first, Social Health Insurance (SHI) does not necessarily deliver good quality care at a low cost. Second, the cost of collecting revenues may be substantial for the formal sector. Third, SHI may have a negative impact on the labour market, including formal sector workers moving into the informal sector. Finally, poor households covered at the taxpayers' expense may be caught in a poverty trap.

2.2.2 Flat rate community premium

The flat rate or per capita community premium is an equal, fixed amount for every individual. The flat rate is computed as the average expected cost of the benefits package to be offered to the entire population. Chile uses the flat rate in its risk adjustment model for open ISAPREs. The community premium is equivalent to the actuarial expected per capita cost from the set of health problems included in the basic guarantees package (GES). This revenue is expected to cover the Solidarity Equalization Fund inter-ISAPREs. Besides, it is expected that the net effect of the model is progressive in risks.[21]

Combinations of both mechanisms, that is, of the income-related premium and the flat rate, are also used. This is the case of the community premiums for each of the sickness funds in Belgium and the Netherlands (Schokkaert and van de Ven, 2003; Lamers et al., 2003). In fact, in external subsidy systems −as in the Netherlands', Belgium's and Israel's risk adjustment systems− consumers pay two contributions: a premium contribution to the sickness fund of their choice; and a solidarity contribution, income-related, that goes directly to a Solidarity Fund. In Israel the premium contribution is zero, so this is not a concern (van de Ven et al., 2001).

[21] A flat rate is income-regressive by definition. When health risks are associated to the population's income, risk adjustment provokes two effects: risk-progressive effects and income-progressive effects.

In the internal subsidy systems −as in Germany's and Switzerland's risk adjustment models− each consumer pays the complete premium to his or her sickness fund, without an explicit community premium going directly to a solidarity fund. In this context, Switzerland imposes community rating per sickness fund, differentiated by region, and the government gives direct subsidies to the poor (Beck et al., 2003). In Germany, premium contributions are proportional to income with a single rate per sickness fund. This could be interpreted as the existence of a premium contribution with a sum of a flat rate premium contribution and a kind of income-related community premium (Schokkaert et al., 2007).

In any case, the basic rationale of risk adjustment does not depend on this choice. Evidently, the impacts are different enough and depend on the degree and type of solidarity that is intended to be introduced. Namely there are two alternatives: (1) risk solidarity and (2) income solidarity. Both may be achieved through the Solidarity Fund.

The external system makes it possible to incorporate any financing equity goal into the system. If there is no explicit income-related solidarity contribution going directly to a solidarity fund, it is less straightforward to implement a specific concept of financing equity (Schokkaert et al., 2007). Therefore, models with income-related premiums and internal risk adjustment (as in Germany and Switzerland) have to take income into account as a risk adjuster, whereas this is not necessary in an external model and of course also not necessary in models with flat rate premium contributions.

2.3. Premium subsidy and risk adjusters

Once the decision to apply a risk adjustment model is made, it is important that the variables chosen as adjusters be relevant to the goals set. That is to say, that the information used allows an important degree of prediction of the health care costs for the group of problems chosen to be covered universally.

2.3.1 Demographic risk adjustment

About 30 countries use risk adjustment models with demographic variables like age and sex (Ellis, 2003) as risk adjusters. In some cases they also include some other relevant characteristics such as sickness subsidies (sickness benefits) and disability (Germany), or mortality (Belgium) (van de Ven et al., 2001; van de Ven et al., 2007).

These are usually cell models. Risk factors are assigned by age groups and sex based on the standardised expected cost of each age group-sex cell. Currently, the Chilean risk adjustment model for ISAPREs is based on 36 sex and age groups, as the relevant variables to predict the costs of the risks groups (Superintendence of Health, 2006 and 2007).

2.3.2 Socioeconomic risk adjusters

From the international experience it is clear that the existing risk adjustment models have gradually incorporated more variables for the calculations of the premium subsidies. First, they included age and sex as adjusters, or only age as in Israel (Shmueli et al., 2003), and later they included variables that improve the prediction of the expected health care costs. For example, they included socioeconomic indicators and health status variables.

Socioeconomic variables are added (to demographic variables) to improve the prediction of health care cost variability. Socioeconomic variables are determinants of health status and, to some degree, of its costs. Socioeconomic variables used include: unemployment status, urbanization, geographical region and income. For example, the Belgium model used age, sex, urbanization, disability, income, status of employment and mortality in an aggregated regression model (Schokkaer and van de Voorde, 2000 and van de Ven et al., 2003). USA (Medicare) and Germany also use socioeconomic variables in their risk adjustment models.

2.3.3 Health status risk adjustment

The most sophisticated risk adjustment models use health status variables as adjusters which increases the accuracy of the predicted costs. The health status variables include individual clinical diagnoses (ambulatory and/or inpatient diagnoses) and/or pharmaceutical prescriptions that identify ambulatory diagnoses (van de Ven et al., 2007). In the USA these variables are used in the programs for the elderly and the poor (Medicare and Medicaid). The Netherlands began to use these variables in 2004 (Prinsze and van Vliet, 2007). First, in 2002, they began using pharmacy-based cost groups (PCGs). In 2004, they applied inpatient diagnostic information (diagnostic cost groups or DCGs) jointly with a socioeconomic variable indicating if the individual was an independent worker (self-employed) (Prinsze and van Vliet, 2007; Wasem and Greβ, 2005). Belgium's demographic risk adjustment model was replaced with the DxCG family model from 2006. Germany, following the reform program, will begin to use this type of model in 2009 (Wasem and Greβ, 2005; Ellis, 2007).

Germany included in 2003 a limited group of chronic or catastrophic diseases in their risk adjustment model, together with a program to manage them, called Disease Management Programs (DMP). The following DMP are included: diabetes, breast cancer and coronary disease (Wasem, 2005).

Another alternative is to combine the adjusters described above. For example, in the case of Medicare in the USA, the model uses demographic variables, some socioeconomic characteristics –linked to the area of residence and the occupation– and also diagnoses, as proxy of the health status of the beneficiaries (Pope et al., 2000).

It is worth mentioning that these models are known because they have achieved a much higher level of prediction of health care costs until now.

Risk adjustment models that incorporate diagnoses to predict the health costs at the individual level improve the predictability of the expenditures' variance at the individual level in comparison to those that only incorporate demographic adjusters. In statistical terms demographic models can only predict approximately 3% of the variance of the individual costs (Adjusted-R^2=0.03) (van de Ven and Ellis, 2000). Models that incorporate other variables, for example, geographical location and institutional status (as in USA), predict 10% of the variance of the individual health expenses (Newhouse, 1989) and models that incorporate diagnoses predict approximately 30% or more (Adjusted-R^2=0.30) of the variance of individual health expenditures (Pope et al., 2000).

The prospective pharmacy-based cost groups risk adjustment model in the Netherlands had a R^2 of 11.5% in 2002 and the model's R^2 reached 22.8% in 2004, when inpatient diagnostic information was added (with DCGs) (Prinsze and van Vliet, 2007). The DCG concurrent model reviewed for Germany reported an adjusted-R^2 of 37.3% and 12% in the prospective model with only inpatient diagnosis (Wasem, et al, 2004; Behrend et al., 2004).

2.3.4 Normative and empirical variables

Finally, there are two other types of variables that can be included in a risk adjustment model: normative and empirical variables.

Normative variables are those that become relevant for political reasons, even when they do not present relevant information for the actual estimation of health care costs. In this case, a specific mathematical or statistical treatment of these normative variables is necessary.

For example, in Belgium, the central fund allocates the funds to each sickness fund. These sickness funds use a health budget which is divided into “normative expenditures” and the “actual expenditures”. Moreover the selection of risk adjusters was difficult, because everyone agreed that it did not make sense to include variables that had no significant effect on expenditures. There was some disagreement regarding whether all significant explanatory variables should be taken up in the definition of the “normative expenditures.” The discussion focused mainly over the medical supply variables. They turned out to be very significant in the regressions, but it was later decided to not include them. However, the exclusion of the medical supply variables was only applied to the “normative expenditures” method. In the “actual expenditures” method, with the risk sharing mechanism, expenditures include all variables −so there are no excluded variables (Schokkaert and van de Voorde, 2000).

In several Latin American and the Caribbean countries, ethnic groups may be considered a normative variable for risk adjustment, even when it has been shown that observed health care costs within different ethnic groups are irrelevant. Nevertheless, it may be the case that some ethnic groups are not accessing the formal health care system and governments want to improve their access. In this case, including ethnicity with an adjusted political and technical formula may provide incentives for the health insurance system to incorporate these ethnic groups and also their health status. Therefore, although empirically, for example in a regression model, these variables would have negative coefficients (as these groups use health care at a less than average rate) they are given positive coefficients based on a political decision.

The empirical variables are those that explain observed health care expenditures, for example: age, sex, socioeconomic variables and health status.

Table 2 shows the risk adjusters used in a selected sample of high-income countries and in Chile. Both social health insurance systems and tax-financed systems use risk adjustment to reallocate resources. Some countries −like the Netherlands, Germany and Belgium− introduced risk adjusters in stages.

Table 2: Risk adjusters in capitation formulas in some high income countries and Chile

Country	Year of implementation	Risk adjusters
Social Health Insurance Systems		
Austria	None	
Belgium	1995	Age, sex, social insurance status, employment status, mortality, urbanization, income
	2006	Age, sex, social insurance status, employment status, mortality, urbanization, income, diagnostic and pharmaceutical cost groups
France	None	
Germany	1994/1995	Age, sex, disability pension status
	2002	Age, sex, disability pension status, participation in disease management program
Japan	None	
Korea	None	
Luxembourg	None	
Netherlands	1993	Age, sex
	1996	Age, sex, region, disability status
	1999	Age, sex, social security/employment status, region of residence
	2002	Age, sex, social security/employment status, region of residence, diagnostic and pharmaceutical cost groups
Switzerland (within canton)	1994	Age, sex
Chile (ISAPREs)	2005/2006	Age, sex
Tax Financed Health Systems		
Country	**Year of implementation**	**Risk adjusters**
Australia		Age, gender, ethnic group, homelessness, mortality, education level, rurality
Canada		Age, gender, socioeconomic status, ethnicity, remoteness
Denmark		Age, number of children in single parent families, number of rented flats, unemployment, education, immigration status, social status, single elderly people
England		Age, mortality, morbidity, unemployment, elderly people living alone, ethnic origin, socioeconomic status
Finland		Age, disability, morbidity, archipelago, remoteness
Iceland		None
Ireland		Not applicable
Italy		Age, gender, mortality, morbidity, utilization
New Zealand		Age, gender, welfare status, ethnicity, rurality
Norway		Age, gender, mortality, elderly living alone, marital status
Portugal		Mainly based on historical precedent; age, relative burden of illness (diabetes, hypertension, tuberculosis, AIDS)
Spain		Percentage of population >65, "insularity" (region=islands)
Sweden		Age, gender, marital status, employment status, occupation, housing tenure, high user

Source: Adapted from Busse et al., 2007.

2.3.5 Ex-ante and ex-post risk adjustment models

Risk adjustment models may be ex-ante (prospective) or ex-post (retrospective) in terms of the time periods required for the analysis. The ex-ante or prospective system uses information from the previous periods (for example, last year) to compute or estimate the standardized expenditures and community premium subsidies reflected in the risk adjusted premiums or premium subsidies. Therefore, the payments are independent from the real costs of the compensated period. These models give efficiency incentives, because health insurers face a higher financial risk. Despite this increase in financial risk, health insurers usually tend to prefer them, because it allows them to manage a known budget for every period.

Table 3: Expenditure information in ex-ante (or prospective) and ex-post (or retrospective) risk adjustment models

Year / Models	t-2	t-1	t	t+1
Ex-post Models	Using expenditure information for preliminary payments	Alternative, using expenditure information for preliminary payments	Risk adjustment period Preliminary payments	Final payments using the real data from t period
Ex–ante Models	Using expenditure information for final payments	Alternative, using expenditure information for final payments	Risk adjustment period Final payments	No adjustment or adjusting only for changes in the enrolees number and structure

Source: Author's analysis from Wasem, 2003.

For example, in Germany, at the end of each calendar year, they compute the standardized expenditures, while during the year they use a preliminary monthly risk adjustment scheme based on a mixture of last year's and the current year's information (Buchner and Wasem, 2001, 2003).[22]

[22] In 2009 Germany started with a partly prospective model: diagnoses from 2008 and costs in each health status group from 2009 are used (Wasem, 2008).

Belgium, Israel, the Netherlands and the USA (Medicare), are examples of ex-ante risk adjustment models, while Germany and Switzerland use ex-post models (van de Ven et al., 2001; Pope et al., 2000; and Wasem, 2003).

The inter-ISAPRE risk adjustment model in Chile is an ex-ante model with final adjustments for changes in the number and distribution of the insured among ISAPREs (Superintendence of Health, 2006). It combines ex-ante and ex-post population information. First, it uses the previous year's expenditures to compute a normalized risk matrix. Then, it uses current population to adjust transfers.

This method avoids gaps in the risk adjustment fund, and maintains the relation between risk factors (standardized expenditures), but if only age and gender are used, the difference between ex-ante and ex-post model is not very important.

In an ex-ante system, an ISAPRE receives a premium subsidy for its enrolees of a given age and gender group determined in the beginning of the period that will not change during the period, regardless of the ISAPRE's expenditures. In an ex-post system, the premium subsidy is determined at the end of the period as the average per capita expenditures for all enrolees in the age and gender group of all ISAPREs for that period. Most age and gender groups are insured in many ISAPREs, so the average expenditures do not depend on the expenditures of a particular ISAPRE. So, if an ISAPRE increases the expenditures to a particular group, it will not have a significant impact on the national average or on the premium subsidy. However, in health status models it does make a significant difference whether the data on diagnoses is current or past. With age it is almost irrelevant.

2.3.6 Cell models and regression models

The international literature about risk adjustment models includes two methods: actuarial or regression. The cell (or actuarial) method uses cells to represent a predefined risk group. Average expenses are calculated per person within the risk group. The group averages are normalized relative to the overall average to obtain a risk factor table. Chile currently uses the cell method in the ISAPREs' risk adjustment system.

The regression method estimates the expected individual or group expenses based on a choice of relevant variables for the risk adjustment. The estimated parameters are standardized and then represent the weight of each variable in each risk group.

The regression model, in general terms, is as follows:

$$Expenditure_{it} = bX_{it} + U_i + e_{it} \tag{1}$$

where:

b : normalized utilization impact give risk factors X

X_{it} : risk factors for individual i and period t

U_i : individual i´s variance in health service utilization (constant over time)

e_{it} : random error independent of X, for individual i and period t

The cell method is more commonly used; both Germany and Switzerland use it (Buchner and Wasem, 2003; Beck et al., 2003). On the other hand, the regression method is used in the USA, Netherlands and Belgium. Belgium used a regression model with aggregated variables and not individual variables, but in 2004, they applied inpatient diagnostic information in an individual regression model (DxCG).

Models that have been in operation for more than 10 years, like the ones previously mentioned, are currently considering switching from the cell model to a regression model. Regression models allow more variables in comparison to the cell model. For example, we can include more socioeconomic and health status variables. Both the Netherlands and Germany (since 2007) have had this experience (Prinzel and van Vliet, 2007; van de Ven et al., 2007).

In models that use only demographic adjusters there is no significant difference between using the cell or the regression method to compute risk factors.[23] This is true because demographic adjusters have such a low explanatory power (see above).

[23] Especially if the regression includes an interaction term between age and gender.

There is considerable difference between regression models and cell models when health status variables are included. In fact, the econometric specification becomes more important. The Medicare risk adjustment system and the systems in the Netherlands and Israel use a regression approach rather than the enumeration of costs for each medical category (like each Explicit Health Guarantee or GES category in Chile) by assumed treatment. This regression approach, while harder to explain, can do a better job at capturing correlations and treatment overlaps of different conditions. The Chilean cell methodology implicitly assumes that all treatments are independent for each GES and that there are no interactions or overlapping treatment costs. For example, the fact that some patients might have their hypertension and diabetes evaluated and treated at the same time is not considered. Consistent with the risk adjustment international experience, it would be desirable for Chile to eventually move to a system using a much richer set of adjusters including medical conditions.

2.3.7 Conventional and optimal risk adjustment

Finally, the literature on risk adjustment has widely recognized that risk adjustment payment formulas should take an active role in creating optimal incentives. This is characterized by the difference between "conventional risk adjustment" (paying the expected cost of each enrolee) and "optimal risk adjustment" (paying an amount for each enrolee that creates incentives for optimal enrolment and treatment decisions). As discussed earlier, in every system, the presence of private information means that health plans can try to take actions to select or attract the most profitable enrolees and avoid the unprofitable. These actions can include: premium setting; benefit design; selective marketing; dumping, exclusions for pre-existing conditions; and service level distortions so to attract healthy and profitable enrolees. Some of these actions can be restricted through regulation, but some cannot. It is useful to think of the risk adjustment cost weights as prices that can be increased or decreased, as desired, to create optimal incentives for the plans (Glazer and McGuire, 2000; Ma, 2003; Ellis, 2007).[24]

The following table summarizes the relevant issues abovementioned and those which follow.

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[24] Chile could use "conventional risk adjustment" techniques and complement it with a payment system that rewards health insurers for enrolling relatively high cost individuals.

Table 4: Relevant issues of risk adjustment models: International experience and the Chilean inter-ISAPRE model

Country	Subsidy System	Consumer's solidarity contribution	Risk Adjusters	Prospective or Retrospective model	Calculation mechanism	Acceptable Costs and/or Benefits package	N° of Risk-bearing sickness funds or insurances	Mandatory risk sharing system
Germany	Internal	Income-related community premium and Income-related premium contribution	Demographic, socioeconomic and morbidity risk adjusters: income, sex, age, invalidity pension, sickness allowances, DMPs	Ex-post	Cell actuary model	Physicians' services, hospital care, prescription drugs, physiotherapy, dental care, restricted home health care, psychiatric care, sick leave payments	275	Yes, but voluntary complementar y high cost pool for outlier risk sharing (since 2002)
Belgium	External	Per capita flat rate community premium and Income-related premium contribution	Demographic, socioeconomic: sex, age, urbanization, disability, income, employment status, mortality, family composition, social status, preferential reimbursement (lower co-payments), diagnosis of invalidity, eligibility of social exemption, chronic illness (until 2006)	Ex-ante	Aggregated regression model	Physicians' services, hospital care, prescription drugs, physiotherapy (restricted), dental care (restricted), home health care, psychiatric care (restricted by co-payments), sick leave payments	6	No
Netherlands	External	Per capita flat rate community premium and income-related premium contribution	Since 2004, health status, demographic and socioeconomic: morbidity with pharmacy-based cost groups, Diagnostic Cost Group (DCGs), sex, age, being self-employed (yes/no)	Ex-ante	Individual regression model PCGs and DCGs	Physicians' services, hospital care, prescription drugs, physiotherapy (restricted), dental care (restricted)	33	Yes, outlier risk sharing and proportional risk-sharing
Israel	External	Per capita flat rate community premium and zero premium contribution	Demographic (age only)	Ex-ante	Cell actuary model	Physicians' services, hospital care, prescription drugs, physiotherapy (restricted), dental care (restricted), home health care (restricted), psychiatric care (restricted)	4	Yes, condition-specific risk-sharing (5 severe diseases)

Table 4: Relevant issues of risk adjustment models: International experience and the Chilean inter-ISAPRE model

Switzerland	Internal	Per capita flat rate community premium and income-related premium contribution	Demographic (sex, age, region)	Ex-post	Cell actuary model	Physicians' services, hospital care, prescription drugs, physiotherapy, home health care, nursing home care, psychiatric care (restricted)	93	No
U.S.A.-Medicare	External	Per capita county rate	Health status and demographic (morbidity with Diagnostic Cost Group (DCGs), including sex, age, region)	Ex-ante	Individual regression model DxCG	Long-term nursing care, dental care, glasses, headphones and a large number of medicines are restricted		No
U.S.A.-Medicaid	External		Health status and demographic (Ambulatory Cost Group ACG, CDPS and others, including sex and age)	Ex-ante	Individual regression model ACG	It changes according to state in U.S.A.		No
U.S.A.-Minnesota	External		Health status and demographic (ACG including sex and age)	Ex-ante	Individual regression model ACG			No
U.S.A.-Massachusetts, Washington state	External		Health status and demographic (DCGs including sex and age)	Ex-ante	Individual regression model DxCG			No
Chile-inter-ISAPRE SCF	Internal	Per capita flat rate community premium and income related premium contribution	Demographic risk adjusters: sex and age only	Principally ex-ante	Cell actuary model	Limited by condition-specific health package for 25 (beginning 2005), 40 (beginning 2006) and 56 in 2007, diseases GES (3% to 5% percent of total ISAPRE expenditures)[25]	14, but only 8 in the risk adjustment system (2008)	No, there are 2 separate systems for catastrophic health problems

Source: Author's analysis from: van de Ven et al., 2007; van de Ven et al., 2001; Ellis, 2002; Wasem, 2005; Pope et al, 2000; and Superintendence of Health of Chile for Inter-ISAPRE risk adjustment fund, 2006 and 2007.

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[25] The total health expenditure of the ISAPRE system (with copayments) was US$ 1,458 million in 2005, and estimated expenditures (by the Superintendence of Health) of the 40 health problems was US$ 44 million

2.4. Acceptable costs

The acceptable costs to be compensated are those that society, by means of some institutional mechanism, has determined must be universally covered. This is essentially a normative decision.

But, in practice, premium subsidies for different groups, in a risk adjustment context, are derived from observed costs of these groups, and it is obvious that it would not make sense to simply equate normative expenditure to actual costs. The definition of acceptable costs includes important demand factors, morbidity, preference variables, demand prices, income, provider characteristics, supply prices, etc. (Schokkaert et al., 2006). These explanatory variables are partitioned into two groups: one containing the variables for which individuals cannot be held responsible and which should be included in the definition of acceptable costs (call these C-variables), the other containing the variables for which individuals and insurers are held responsible because they reflect differences in subjective tastes or differences in efficiency (call these R-variables). This partition necessarily reflects ethical and political considerations of the particular country (Schokkaert et al., 2006). Therefore, acceptable costs imply the distinction between legitimate and illegitimate risk adjusters and the difficult ethical trade-offs between equity and cost-effectiveness.

2.5. Benefits package

The decision about what to include in a basic benefits package is a priority setting question in the health care sector. Different countries have made different decisions in this regard (van de Ven et al., 2003; van de Ven et al., 2007). Typically, dental care, physiotherapy and psychiatric care are examples of health care problems that are included in the benefits package by some countries and excluded by others.

In general, excluding health problems or health interventions from the benefits package used in the determination of the risk adjusted premiums creates incentives for risk selection. If insurers do not receive reimbursement for expenditures on items excluded from coverage, there is clearly no reason to include them in the risk adjustment formula.

A benefits package may be determined using different methods. For example, the UK has a national health system −National Health Service (NHS) − and the benefits package is determined by the National Institute for Clinical Excellence (NICE) (state-run) with the participation of the different actors.

Switzerland and Germany have social health insurance systems, with some differences. Germany defines its benefits package based on corporate relations of the autonomous agents of the state, while Switzerland's state institutions dictate the benefits package without a significant participation of other agents (Greβ et al., 2004).

European health benefits packages are very comprehensive and inclusive. In general, the discussion centres on the exclusion of some specific treatments (associated with plastic surgery, for example), or the inclusion of new treatments (for example, new procedures developed with new technology or pharmaceuticals).

Finally, the health care market and individual private insurance market in the USA determine their benefits packages based on the market −consumer decisions and their payment capacity. This criterion, although common in USA's private sector, is not considered acceptable in Europe (Greβ, 2004) or in Medicare's risk adjustment system in USA, in both cases for equity reasons.

In Chile, the acceptable costs are those in its benefits package, the "Explicit Guarantees in Health" (Garantías Explícitas de Salud – GES). Chile used a combination of criteria to select the health problems to include in GES. The criteria included cost-effectiveness, health needs of the population and response capacity of the public providers' network (Health Reform Commission, MINSAL, 2003). Furthermore, health problems were introduced in stages: in July 2005, 25 "health problems" (diseases) were selected; and later, in July 2006, the GES was expanded to include 15 new health problems. Finally in July 2007, a total of 56 health problems were included.

2.6. Extreme or catastrophic costs

An important issue that a model needs to consider is extreme or catastrophic costs. As mentioned above, demographic variables can only predict a very small percentage of the variance of the individual health care costs. In fact, models that only use demographic variables do not satisfactorily predict high cost events, although high cost events may represent a high proportion of total expenditures.

Several systems define a special scheme to compensate for these extreme health care costs and to reinforce the incentives of mitigation of risk selection. These models are known in the literature as “risk-sharing” systems (van Barneveld et al., 2001). They can be designed for specific health conditions or acceptable predefined costs, where the diagnoses and even the treatment algorithms are previously determined. These can be constructed as threshold costs systems, also known as “outlier risk sharing,” that are more commonly used to address more unpredictable events, i.e., accidents. For example, the Netherlands uses outlier risk sharing for high costs, while Israel uses risk sharing for specific health conditions (van de Ven et al., 2001). In 2002, Germany introduced mandatory risk sharing for high costs (Wasem, 2005), because the Social Health Insurance System had an important risk selection problem even with the existing risk adjustment (Buchner and Wasem, 2001).

In practice, these systems may predefine a list of catastrophic diseases, or simply, define an expenditure threshold for health events. As such, if a health event is considered catastrophic, it requires a different type of financing. For example, catastrophic costs may be partially recovered with financing from reserves within the risk adjustment fund. This mechanism is known as proportional risk sharing.

Table 5: Risk sharing models

Risk sharing Model	Main characteristic of the model	Some European Countries
Proportional risk sharing	A plan is reimbursed for a certain fraction of all actual costs of all members	Belgium, Netherlands
Outlier risk sharing	Health plans are (partially) reimbursed for the expenditures of all members above a certain threshold	Germany, Netherlands
Risk sharing for high costs	Plans are reimbursed for the expenditures of a small, fixed fraction of the members who were actually the costliest	
Risk sharing for high risks	Plans are reimbursed for the expenditures of a small, fixed fraction of their members that the plans themselves have designated for risk sharing in advance	
Condition-specific risk sharing	Covers some severe diseases and a small percent of overall expenditures	Israel

Source: Author's analysis from van Barneveld et al., 2001; van de Ven et al., 2001; and Wasem et al., 2005.

In Chile, both FONASA and ISAPREs have implemented complementary systems to deal with catastrophic or high costs. FONASA has a system similar to risk sharing for high risks, while ISAPREs have a system similar to risk sharing for high costs

ISAPREs have a network of catastrophic and emergency care. The scheme's goal is to re-insure high co-payments for the costs of emergency services. The fund was created with a US$1 increase in all premiums (per beneficiary per month). Participation in this system is voluntary. In fact, most, but not all, ISAPREs participate in this scheme. Furthermore, the scheme is not regulated and it functions within each ISAPRE, hence there is no risk pooling[26] between ISAPREs. The private sector's catastrophic system does not appear to have prevented risk selection, nor has it had the desired effect on premium prices. On the contrary, it has increased premium prices. Also, from a regulation viewpoint and according to the European experience, high risk insurances should assume greater liability of individuals' health expenditures but this has not occurred in the Chilean private sector. Insurers' financial liability has not increased despite the existence of the catastrophic disease insurance.

[26] We understand that pooling of funds describes the accumulation of prepaid health care resources to cover financial risks that exceed an individual's or an intermediary's ability to pay (Busse et al., 2007)

FONASA has a program of complex interventions that lists the interventions defined as catastrophically costly that are covered by FONASA. For any intervention, providers must first be accredited. FONASA then establishes a maximum fee for the procedures based on average prices. This determines the global budget, which also defines the maximum allowable expenditure. Providers then bid to deliver these interventions financed by the program at prices less than or equal to the prices set by FONASA.

The following table shows some of the key characteristics of these two systems in Chile.

Table 6: Catastrophic systems in FONASA and ISAPREs

	FONASA	ISAPREs
Potential Beneficiaries	8 million of people	2.5 million of people
Catastrophic insurance definition	Cardiac surgery, neurosurgery, kidney and liver transplants, non-surgical cancer treatment, scoliosis, severe burns, palatine care and immunosuppressive drugs	Events for which co-payments are between $1-2 million. Exclusions: AIDS, infertility, psychiatric and dental care
Premium	Not identified	Initially about $700 (US$1) per month per beneficiary. Currently not identified
Total expenses per year	$16.623 million (US$ 23.7 million)	$4.725 million (US$ 6.7 million)
Direct beneficiaries	13,756 (0.14%)	1,500 (0.07%)
Threshold	None	Yes, $1 million (US$ 2,000) accumulated in one year

Source: Adapted from "A proposition for designing pool of "outliers" in the Solidarity Compensation Fund", MINSAL-Chile. Vargas, Angulo, Sánchez, Cid and Wiyuker, March 2003.

The Health Reform in Chile also includes an expenditure ceiling for each contributor (and his family) to avoid a health event from becoming a financial catastrophe for the families. In fact, there is a fixed co-payment of 20% for the interventions in GES, with a ceiling. Table 7 summarizes the expenditure ceilings. For ISAPREs, the co-payment ceiling is 21 times the premium contribution, which is approximately US$ 3,268 on average.

Table 7: Additional financial coverage (only GES Health Problems)

	1 health event	2 or more health events
ISAPREs	21 times the premium contribution	31 times the premium contribution
FONASA	29 times the premium contribution	43 times the premium contribution
Yearly ceiling (average)	US$ 3,268	US$ 4,848

Source: Author analysis.

In sum, in order to have a risk sharing system that avoids risk selection, the system must include risk pooling. In the case of Chile, this risk pooling should be across FONASA and ISAPREs, or at least between ISAPREs.

III. MAIN PROBLEMS IN THE CHILEAN HEALTH CARE SYSTEM

The Chilean health insurance system has risk selection as one of its main problems. Risk selection, unavoidably, translates into an inefficient health care system, which is detrimental to social welfare and a wasteful use of resources. It is considered as advantageous to the health care system as a whole, and an achievement to social welfare, that insurance companies enforce competition for "financial" efficiency and, specially, for health care service quality in the framework of a social security system. In this context, the following issues are the more important problems in the Chilean health care system.

This chapter reviews the problems of the Chilean health sector. As mentioned above, we show that the Chilean health care system works with high degrees of inefficiency and inequity. We show the inequities in the system by analysing the expenditures per groups of individuals, the existence of a segmented market and the population distribution in ISAPREs versus FONASA.

1. Inequity in the financing and expenditures

1.1. Health national accounts

The health care national accounts are summarized in Table 8. In Chile, total health care expenditure as a proportion of GDP is 7.6%, with ISAPREs and FONASA accounting for 5.5% of this amount (FONASA, 2001). Private sector expenditures (ISAPREs) cover less than 20% of the population, and account for 2.6% of GDP, whereas the public sector (FONASA) covers 67% of the population and accounts for 2.9% of GDP. ISAPREs' expenditure per capita is almost three times that of FONASA. In 2000 the per capita expenditure in FONASA was US$ 201, while in ISAPREs it was US$ 557.[27]

In a national accounts context, FONASA's and ISAPREs' main sources of revenues are: the income-related premium contributions (7%), central government contributions from the Treasury

[27] These numbers include profits within the ISAPRE system.

and out-of-pocket contributions. ISAPREs receive the mandatory and voluntary premium contributions. FONASA receives government subsidies for the poor, while ISAPREs receive small subsidies for maternity leave payments. Finally, out-of-pocket expenditures account for co-payments and drug expenditures.

ISAPREs finance their overall expenditures through individuals' mandatory and voluntary contributions (66%) and with out-of-pocket contributions (33%). FONASA finances its expenditures as follows: 42% from the government transfers, 36% from individuals' contributions and 22% from out-of pocket contributions −including co-payments. Government contributions to FONASA represent 1.65% of GDP, of which 1.23% corresponds to FONASA and the rest to other public goods (including 0.28% allocated to ISAPREs), which represents 49% of the health sector's total financing.

In sum, the Chilean health care system's financing depends largely on individuals' contributions and co-payments.

Table 8: Total expenditures and financing in Chile, 2000 (US dollars, 2000)

	Contributions	Fiscal Financing	Out-of-pocket exp.	Total	%GDP
FONASA					
Health Services	548,021,583	809,137,738	192,955,927	1,550,115,248	2.35%
Sickness allowances	126,768,876			126,768,876	0.19%
Pharmaceutical expenses			222,394,706	222,394,706	0.34%
Administration	21,769,575			21,769,575	0.03%
Subtotal FONASA	***696,560,034***	***809,137,738***	***415,350,632***	***1,921,048,404***	***2.91%***
ISAPREs					
Health Services	720,526,297	16,160,858	350,834,672	1,087,521,827	1.65%
Sickness allowances	18,409,932			18,409,932	0.28%
Pharmaceutical expenses			212,692,952	212,692,952	0.32%
Administration	216,906,475	4,917,231		221,823,706	0.34%
Subtotal ISAPREs	***1,121,532,095***	***21,078,089***	***563,527,625***	***1,706,137,808***	***2.59%***
Subtotal ISAPREs + FONASA	***1,818,092,128***	***830,215,827***	***978,878,257***	***3,627,186,212***	***5.50%***
OTHERS					
Public goods		278,920,165		278,920,165	0.42%
Mutual System	321,839,422		3,532,514	325,371,935	0.49%
Army	79,304,324	31,609,276	15,771,461	12,668,506	0.19%
Other (without insurance)		1,571,558	640,801,145	642,372,704	0.97%
Subtotal OTHERS	***401,143,745***	***312,100,999***	***660,105,120***	***137,334,986***	***2.08%***
TOTAL CHILE	**2,219,235,873**	**1,142,316,826**	**1,638,983,376**	**5,000,536,076**	**7.58%**
% GPD	**3.36%**	**1.73%**	**2.48%**	**7.58%**	

Source: Calculated by the author from *Estudio de Cuentas Nacionales*. FONASA, 2000.

1.2. Financial implications of the regulatory framework of ISAPREs

ISAPRES have individual income and risk-related premiums offered through an array of health plans.[28] Since July 2005 when the reform took place, ISAPREs set their premiums in two parts: one based on GES and the other based on the complementary plan. The GES part is set by each ISAPRE for all its beneficiaries. The complementary plan part represents the larger proportion of the total premium and of the benefits. It is important to note that as GES continues to include more health problems in its package this proportion will decrease.

[28] In the Chilean private insurance market there are approximately 40,000 different health plans currently in use, of which about 10,000 are commercialized (Source: Superintendence of Health, December 2004).

The full premium is a base price multiplied by a risk factor based on sex and age groups. These risk factors are supposed to represent the expected costs. The Superintendence regulates the structure and ratios as follows: there are 36 sex and age groups, and the ratio between the lowest and highest factor cannot be greater than 11 for men and greater than 9 for women. Given that insurance contracts have a one-year duration, each ISAPRE determines its base price annually. The Superintendence regulates the price increase rate by setting a price range of plus or minus 30% of the average price.

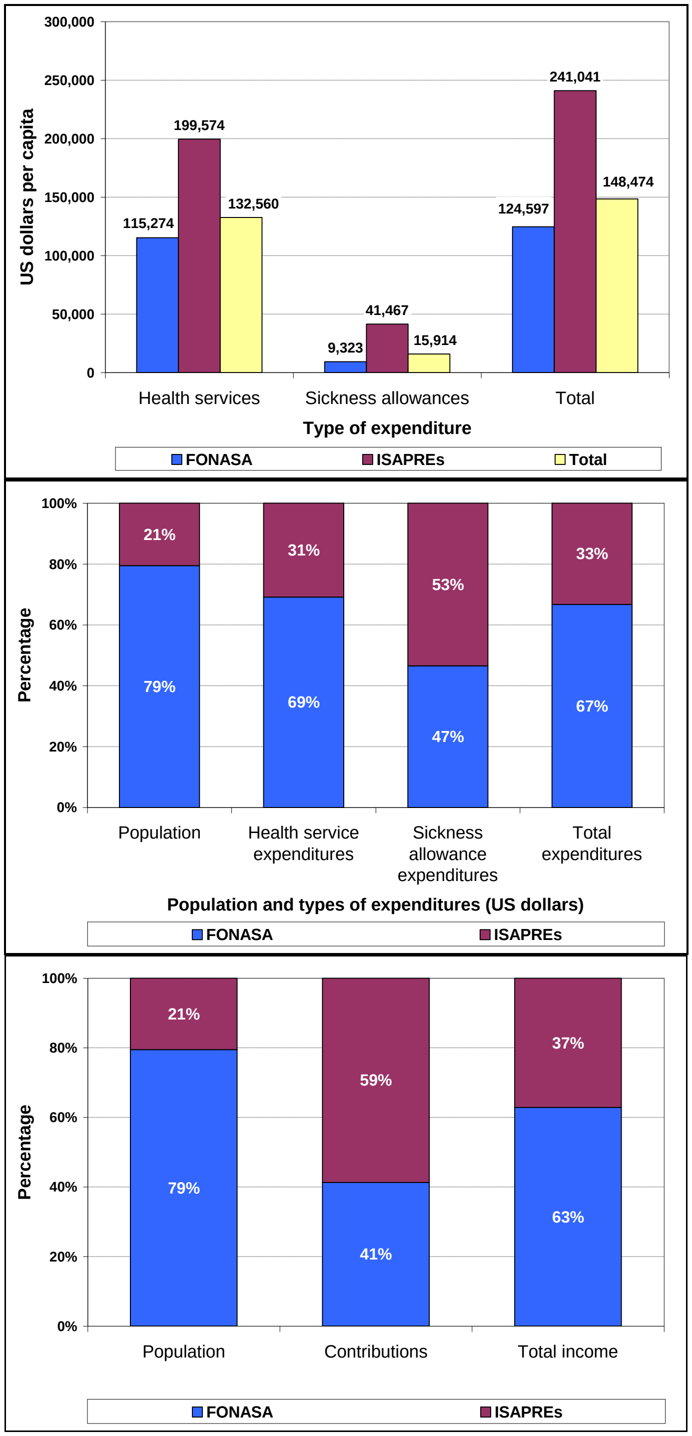
Notice that after a year, the price for an individual changes based on the change in the base price and in the sex and age group risk factor. For example, in the last base price increase announced in July 2008, the real increase was 8% but some individuals' prices could vary as much as 25% for those individuals who move on to the next age group (recall that risk factors are increasing in age).

The public sector works like a pool or a "pay as you go" system with a single implicit plan and redistribution of resources. Nevertheless, given the characteristics of the population who use the public sector, solidarity is built from people of average and low income towards the poorer population and from healthy individuals to sick (Bitrán et al., 1996; Sanhueza, 2000). Therefore, in FONASA poor and middle income individuals' contributions generate a pooled fund. There is no pooling or redistribution between the private and public sectors, except for the indirect subsidies that come from the income tax collection.

1.3. Expenditures per capita

Given the previous information, it is not surprising that the health financing distribution in Chile, between the public and the private sector, is inequitable –assuming equal need for health for every person, regardless of his or her health insurance affiliation. If we assume that the poor have more health needs, the inequity is even greater (there is a long standing empirical analysis of this finding in many countries (World Bank, 1993)).

Figure 6: Expenditure per capita, total expenditures distribution, and total income, FONASA and ISAPRE, 2003



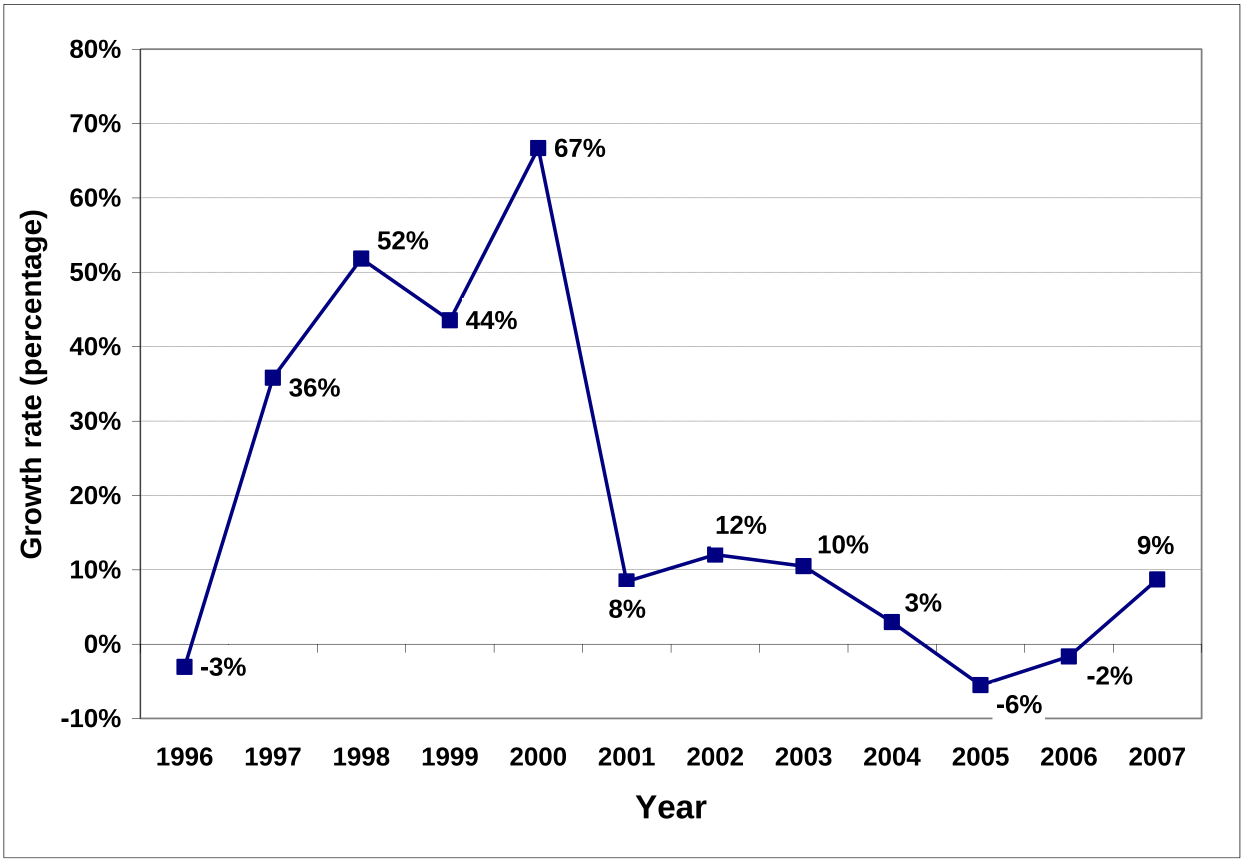
Source: Author's analysis from FONASA 2003 and Superintendence of health, 2003

In 2003, 59% of the total contributions received by FONASA and ISAPREs went to the private sector and only 41% to FONASA. FONASA finances the rest of its expenditures with additional fiscal transfers. It should not come as a surprise that if benefits were measured monetarily, these would also show great differences across sectors. Health expenditures per capita are more than double in the private system, without considering the high administration costs in ISAPREs. In 2003 the administration expenditure represented 14.4% of ISAPREs' operational income.

Figure 7 shows the change in the health care expenditure gap between ISAPREs and FONASA (gap growth) between 1996 and 2005.[29] The gap growth increased between 1996 and 2004, and then fell by 6 % in 2005, almost a decade after the last negative growth in 1996 (3%). Finally, in 2007 it rose again by 9%.

[29] The gap is the difference in health care expenditure per beneficiary in ISAPREs relative to FONASA.

Figure 7: Growth of the per capita expenditures gap between ISAPREs and FONASA, 1996 - 2007



Source: Author's calculations using information from the Statistical Bulletins FONASA and Superintendence of ISAPREs.

Table 9 shows that total expenditure per capita grew faster in ISAPREs than in FONASA. Although ISAPREs' growth rate is driven by medical expenses, in the case of FONASA it is driven by sickness allowances. This is due to a rise in real wages of FONASA beneficiaries, and this is clearly external to the health care system.

Table 9: Per capita expenditure gap between ISAPREs and FONASA, 1995-2005, US dollars, 2005

	Total expenditures per capita		Health service expenditures per capita		Sickness allowances expenditures per capita	
Year	**FONASA**	**ISAPREs**	**FONASA**	**ISAPREs**	**FONASA**	**ISAPREs**
1995	215.86	326.75	155.47	181.49	8.93	44.88
1996	234.16	348.26	172.09	197.31	10.43	50.56
1997	242.69	369.99	181.97	216.22	11.70	58.14
1998	257.44	405.15	189.45	241.45	13.92	62.88
1999	264.45	441.62	190.55	265.19	15.01	66.86
2000	256.19	475.16	182.30	306.73	15.53	75.10
2001	290.14	512.72	209.22	344.13	17.28	77.56
2002	280.14	537.65	215.98	367.13	18.11	79.93
2003	290.39	574.05	224.18	391.14	18.13	80.64
2004	306.27	608.54	234.60	406.47	18.69	80.87
2005	317.57	631.16	244.19	406.55	22.07	88.46
2005/1995	**1.47**	**1.93**	**1.57**	**2.24**	**2.47**	**1.97**

Note: Does not include ISAPREs' profits.
Source: Author's analysis using information from FONASA and Health Superintendence

1.4. Financial situation of ISAPREs and FONASA

This section presents ISAPREs' and FONASA's financial statements. With this information we assess the insurers' financial responsibility estimated as the expenditures made on affiliates and how these are financed. The financial responsibility is the extent to which an additional "peso" (or dollar, or euro) spent on a beneficiary by an insurer is reflected in its own financial results (van de Ven et al., 2001).

Please note that the information presented in this subsection is not equivalent to that presented in the previous section in Table 8. For example, an important difference relates to co-payments: ISAPREs' financial statements do not have information on copayments, because these are not part of their income. The information on co-payments is therefore taken from providers' statements. Something similar occurs with FONASA in that the co-payments presented in this section do not represent total co-payments. Many co-payments are made directly to public hospitals and are registered as the regional health service's own income and not as part of FONASA's income.

1.4.1 Income and expenditures

As seen in Table 10, FONASA's financial reports indicate that its financing sources include fiscal contributions (54% of their resources), beneficiaries' direct mandatory contributions of 7% of their payroll (35.5% of the total), co-payments made directly to FONASA (6%) and other operational income of the public health providers (4.6%).

Table 10: FONASA's financing sources, 2005, thousand of US dollars 2005

Sources	Thousand of US dollars	%
Fiscal expenditure (Treasury)	1,905,696	54.0%
Premium contributions (7% of beneficiaries' income)	1,252,980	35.5%
Operation earnings	160,917	4.6%
Co-payments	211,871	6.0%
Total	**3,531,464**	**100%**

Source: Statistical Annual, FONASA, 2005.

In turn, the bulk of FONASA's expenditures are allocated largely to its own provider network (63%), i.e., to public health care providers, and in a much smaller proportion to the free choice mechanism (14%) (Table 11). The free choice mechanism is a demand subsidy that some FONASA beneficiaries have access to. It gives them the choice of seeking care at an affiliated private provider.

Although FONASA beneficiaries cannot buy complementary plans in ISAPREs −affiliation is exclusive− they could use the free choice mechanism (MLE) to seek care with private providers. In fact, 95% of MLE goes to private providers.

Table 11: FONASA expenditures, 2005, in thousand of US dollars 2005

Expenditures	Thousand of US dollars	%
Institutional health care services (MAI)	2,221,614	62.9%
Free choice health care services (MLE)	493,814	14.0%
Administration expenditures	52,724	1.5%
Sickness allowances	245,394	6.9%
Health care for non-enrolled individuals	103,738	2.9%
Public health programs	203,499	5.8%
Expenditures of Public Health Sector Institutions	210,682	6.0%
Total	**3,531,464**	**100.0%**

Source: Statistical Annual, FONASA, 2005.

Table 12 shows the financing sources of ISAPREs. Premiums represent almost 100% ISAPREs' income, and only 72.3% comes from the mandatory premium of 7% of beneficiaries' taxable revenue. The complementary premiums account for 25.6% of total income. These are the voluntary premiums with which the ISAPREs' beneficiaries finance their risk-related plans.

Table 12: ISAPREs' financing sources, 2005, in thousand of US dollars 2005

Sources	Thousand of US dollars	%
Mandatory premium contributions (7% of income)	1,213,572	72.3%
Additional contributions	6	0.0%
Voluntary premium contributions	429,369	25.6%
Companies' contributions	36,149	2.2%
Total	**1,679,096**	**100.0%**

Source: Statistical Bulletin Superintendence of Health, 2005. http://www.supersalud.cl

ISAPREs spend 64.2% of their total expenditures on health care services. Subsidies for work disability (sickness allowances) represent an important portion of the expenditures because they are based on income and hence are higher in the private sector (14% of ISAPREs' expenditures and 6.9% of FONASA's expenditures). ISAPREs spend 14.5% on administration and sales, while FONASA only spends 1.5%. The final operational result (profit) in the ISAPRE system is approximately 6.8%.

Co-payments do not appear in ISAPREs' financial statements, since these are reported directly by private providers for all ISAPRE beneficiaries. Nevertheless we can estimate them as the expenditures reported by private providers minus the expenditures reported by ISAPREs. In 2005, estimated co-payments were approximately US$ 476.5 million or 36% of the total expenditures of ISAPRE beneficiaries.[30]

Table 13: ISAPREs' expenditures, 2005, in thousand of US dollars 2005

Expenditures	Thousand of US dollars	%
Health care services	1,077,328	64.2%
Sickness allowances	235,322	14.0%
Other expenditures	7,777	0.5%
Subtotal	***1,320,427***	***78.6%***
Management expenditures	244,097	14.5%
Net operating profit/loss	114,572	6.8%
Total	**1,679,096**	**100.0%**

Source: Adapted from Superintendence of Health. http://www.supersalud.cl

1.5. Out-of-pocket expenditures in Chile: Inequity and impact on households

In this section we assess the health care out-of-pocket expenditures. We use data from a household survey to measure out-of-pocket expenditures.

We use the Family Budget Survey for Greater Santiago from the Chilean Statistical Institute (INE) that has data from August 1996 and July 1997. The survey includes household incomes and expenditures for a sample of 8,445 households. This sample is representative of Santiago's Metropolitan Area and it represents approximately 40% of the Chilean population. Expenditures are disaggregated at the product level. By aggregating health products we can compute household health expenditures. The ability to pay is measured as a household's expenditures, minus subsistence expenditures defined as the poverty line. Following WHO's methodology (Aguilar 2006, WHO-Xu, 2005), households that spend over 40% of their available income –measured as

[30] This was calculated using the database of the Superintendence of Health.

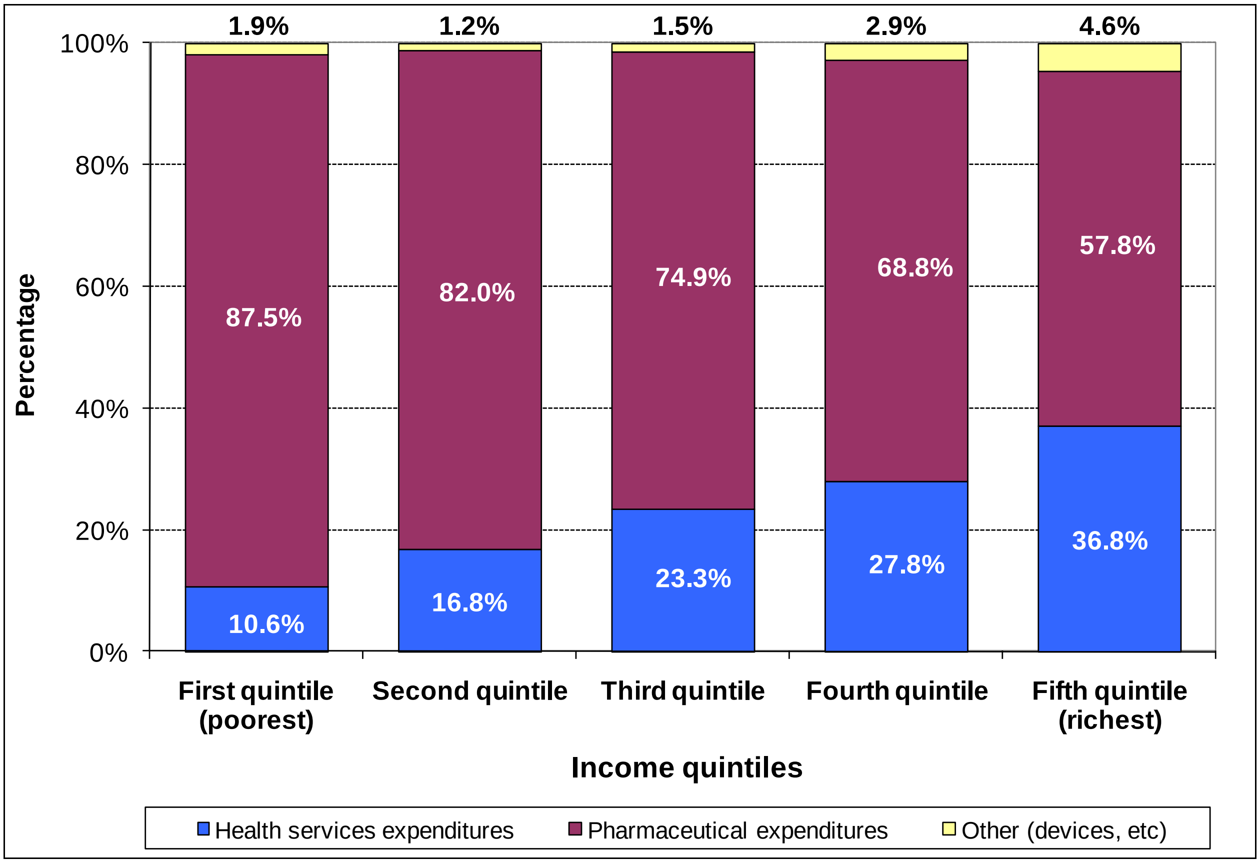
income minus subsistence expenditures− on health care or drugs are considered to have catastrophic health expenditures.

To establish utilization trends we run a regression using variables such as: proportion of children; proportion of elderly; urban or rural area; public or private services; income quintile; ethnicity; etc. Then we estimate a logistic regression for the probability of being at risk of catastrophic expenditures and impoverishment. In the logistic regression we use the same variables as above and other variables such as: occupation, gender, type of insurance, and self-medication. When we include type of worker (dependent or independent), education, and household size, only two variables are statistically significant in the logistic regression: high income quintile and elderly individuals.

About 2% of households show catastrophic expenses using the WHO parameters, and about 14% of households show expenses of over 10% of their available income. Households with higher incomes are those which have higher out-of-pocket expenditures in health, i.e., in the higher income groups, both in absolute and relative terms.

Figure 8 shows the composition of out-of-pocket expenditures by income quintile. The most important group is purchases of medicines and drugs and it is larger among the poorest groups. The second most important expenditures are health care co-payments or health services expenditures.

Figure 8: Distribution of household out-of-pocket expenditure, by income quintiles



Source: Elaborated by the author using information from the Family Budget Survey for Greater Santiago INE 1997.

Out-of-pocket expenditures depend on a household's income. The poor (households in the first income quintile) spend almost nothing on ambulatory care and on hospital health care services. Most of their expenditures are on pharmaceuticals. If we include expenditures on auxiliary health supplies (devices, prosthesis, eye glasses, etc.) both expenditures represent almost 90% of the out-of-pocket expense.

The most important expenditure –pharmaceuticals– is clearly regressive, because the poorest households spend more on pharmaceuticals than non-poor households. On the other hand, with expenditures on doctor visits and dental care the opposite occurs.

The first income quintile includes individuals in FONASA's groups A and B. This quintile generally does not make co-payments, though they may spend on a doctor's visit outside

FONASA's provider network (which is free for them). FONASA's groups C and D affiliates may also be partially represented in the first quintile because if they have many dependents, the household income per capita falls. FONASA's groups C and D are the groups most likely to seek care outside FONASA's provider network, because they are the higher income groups in FONASA.

Affiliates in groups A and B of FONASA have drug coverage in the Primary Health Care Level and hence should not need to incur in drug expenditures. Drug expenditures represent the purchase of low cost drugs for health problems that require simple treatments and antibiotics. They can be prescribed by private medical doctors −outside the public network− which are not covered by FONASA. In sum, they incur in drug expenditures when they seek drugs that are not covered, when the drugs are not available or when they choose to self-medicate.

On the other hand, the fourth and fifth quintiles, in spite of the fact that they spend over half on pharmaceuticals (69% and 58%, respectively), the second most important out-of-pocket expenditure is doctor visits which represent 28% and 37%, respectively.

The main expenditure of high income groups and the least important of the poorest groups are a reflection of the differences in their ability to pay, and also the differences in price levels between the suppliers used by each group. Regardless, these relationships do not reflect health needs by quintiles. It is of concern that the poorest quintiles allocate a smaller portion of their income to health care, simply because they cannot allocate any more, even when they most likely have greater health care needs.

We compute the Gini coefficients for household income and health care expenditures.[31] The Gini coefficient indicates how far the actual distribution is from a perfectly egalitarian distribution and

[31] The Gini coefficient was computed using the following formula (Wagstaff and van Doorslaer, 2000):

measures the area between the Lorenz curve and the 45 degree line, relative to the total area below the 45 degree line. The Gini coefficient lies between zero and one, where a value of zero is a perfectly egalitarian distribution, and one is maximum inequality.

$$Gini = \frac{\sum_i \sum_j |x_i - x_j|}{(2N^2 \mu)}$$

where:

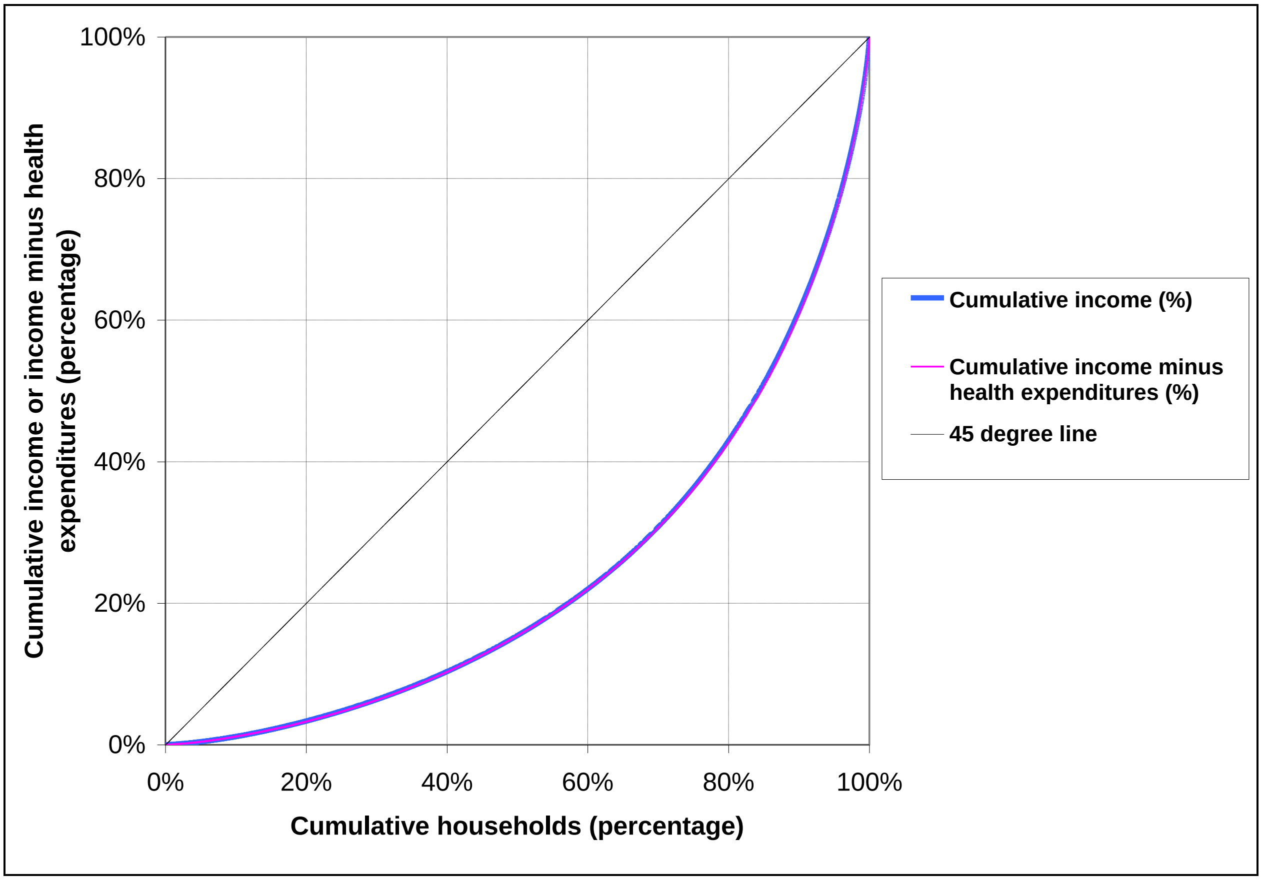
x_i : household i's expenditure

x_j : household j's expenditure

N : total number of household

μ : sample mean of the expenditure

Figure 9: Lorenz curves for income and income minus health expenditures, 1997



Source: Elaborated by the author using information from the Family Budget Survey (INE, 1997).

At 0.76, the Gini coefficient for out-of-pocket health care expenditure in Chile (in Santiago's Metropolitan Area, also known as Greater Santiago) is very high. This means that the distribution of out-of-pocket health expenditure is very unequal. The richest quintile spends nearly 40 times more on health than the poorest quintile. In the case of overall consumption, the distribution of health expenditures concentrates excessively in the high-income quintiles,[32] with the richest quintile consuming 11 times more than the poorest quintile.[33]

[32] The autonomous income Gini coefficient –computed using the CASEN (representative at the country level) in 1996– was 0.57 and 0.56 for monetary income (defined as transfers) (MIDEPLAN, 2001).

[33] The income surveys in Chile (CASEN) show that in the case of income this indicator has ranged between 13 (1992) and 15 times (1998), in 1996, the year nearest to this survey, it was 14.6 times, and in 2003 it was 14.3 (MIDEPLAN, 2004).

Table 14: Gini coefficients for per capita household income and per capita household out-of-pocket health expenditures, Greater Santiago, 1997

Type of Gini coefficient	Value of Gini coefficient
Gini of the per capita household income	0.55
Gini of the per capita household income minus out-of-pocket health expenditure	0.56
Gini of per capita out-of-pocket health expenditure	0.76

Source: Author's calculations using data from the Family Budget Survey (INE, 1997).

A high Gini coefficient, as the one shown for out-of-pocket health expenditures, shows two things: first, that the out-of-pocket health expenditure is highly unequal; and second, that it is proportionally higher for higher income households. After subtracting the out-of-pocket expenditures from the Gini of the income, the income Gini coefficient slightly increases from 0.55 to 0.56.[34] In sum, as ability to pay increases, the proportion of out-of-pocket health expenditure also increases; as such, higher income groups spend more on health beyond the income gap relative to other income quintiles.

It is likely that higher income groups compensate for the health plan deficiencies relative to their expectations with direct health expenditures. On the other hand, poor income groups with their smaller level of absolute expenditure spend mostly on pharmaceuticals and other supplies.

The low pharmaceutical, dental and psychiatric coverage of private health plans as well as the slow access to public services are also of importance here. Furthermore, the preferential use of free choice in comparison to the private sector's closed plans, and the differences in prices between the public and private sectors (and even within the private sector) may be responsible for the very high co-payments for individuals that use more exclusive providers.

In sum, we show that there is inequality in health financing because of the high out-of-pocket expenditures in Chile. Because these expenditures (mainly on pharmaceuticals and health

[34] Health expenditure tends to follow the same regressiveness as household income in Chile. Nevertheless, we computed the Gini coefficient for total autonomous revenue and the Gini coefficient of the total autonomous revenue minus health expenditures. The first is 0.55, while the second 0.56.

services) have an important impact on a household's budget, authorities should consider including them as part of the entire insurance system's financial responsibility.

1.6. Segmented health system

Risk selection is expected to result in a segmented market whereby the low risk individuals pay a low premium and the high-risk pay a high premium or they are eliminated (van de Ven et al., 2001). As such, we expect to find segmentation when some insurers are successful in attracting the low-risk consumers.

As we can see in Table 15, the public sector (FONASA) in Chile has been responsible for insuring a large proportion of the population for many years, though there have been periods of high affiliation in ISAPREs which coincide with periods of high economic performance. For example, in 1997 26.1% of the population were ISAPRE beneficiaries, and GDP growth in that year was 6.6%.

Table 15: Distribution of the population by insurance system 1990 – 2007

Year	FONASA	%	ISAPREs	%	Other insurers	%	Total population	Real GDP growth rate (%)
1990	9,729,020	73.1	2,108,308	15.9	1,463,068	11.0	13,300,396	3.8%
1991	9,414,162	69.5	2,566,144	18.9	1,563,320	11.5	13,543,626	7.9%
1992	8,788,817	63.7	3,000,063	21.8	1,997,977	14.5	13,786,857	12.2%
1993	8,537,786	60.9	3,431,543	24.5	2,060,762	14.7	14,030,091	7.0%
1994	8,644,479	60.6	3,669,874	25.7	1,958,971	13.7	14,273,324	5.7%
1995	8,637,022	59.6	3,763,649	26.0	2,094,551	14.4	14,495,222	10.5%
1996	8,672,619	59.0	3,813,384	25.9	2,209,787	15.0	14,695,790	7.4%
1997	8,753,407	58.8	3,882,572	26.1	2,260,383	15.2	14,896,362	6.6%
1998	9,137,599	60.5	3,679,835	24.4	2,279,496	15.1	15,096,930	3.3%
1999	9,403,455	61.5	3,323,373	21.7	2,570,671	16.8	15,297,499	-0.7%
2000	10,157,686	65.6	3,092,195	20.0	2,234,851	14.4	15,484,732	4.5%
2001	10,156,364	64.9	2,940,795	18.8	2,561,472	16.4	15,658,631	3.3%
2002	10,327,218	65.2	2,828,228	17.9	2,677,085	16.9	15,832,531	2.2%
2003	10,580,090	66.1	2,729,088	17.0	2,697,251	16.9	16,006,429	4.0%
2004	10,910,702	67.4	2,678,432	16.6	2,591,194	16.0	16,180,328	6.0%
2005	11,120,094	68.0	2,660,338	16.3	2,569,549	15.7	16,349,981	5.6%
2006	11,479,384	69.5	2,684,554	16.3	2,351,436	14.2	16,515,374	4.6%
2007	11,740,688	70.4	2,776,912	16.6	2,163,173	13.0	16,680,773	4.7%

Source: FONASA, 2007. http://www.fonasa.cl

FONASA covers 91.1% of the lower income population, in comparison to the 1.6% covered by ISAPREs (Table 16). Individuals in the richest quintile are more likely to be insured with an ISAPRE than with FONASA. In fact, 50% of ISAPREs' beneficiaries are in the highest income quintile, while in FONASA they only represent 9.3% of beneficiaries (CASEN 2006, MIDEPLAN, 2008).

Table 16: Population distribution by insurer and income quintile

Insurer	Income Quintile I	II	III	IV	V
FONASA	91.10	85.40	76.40	60.50	33.60
ISAPREs	1.60	5.60	11.20	24.00	50.50
None	5.90	6.30	7.30	8.30	9.20
Army Forces	0.60	1.60	3.90	5.50	5.10
Other System	0.10	0.10	0.20	0.20	0.40
Unknown	0.60	1.00	1.10	1.40	1.20
Total	**100**	**100**	**100**	**100**	**100**

Source: MIDEPLAN, 2005.

FONASA covers nearly 80% of the population over 65 years of age, while ISAPREs cover only 7% (World Bank, 2000). This means that 9% of FONASA's beneficiaries are in this age group, while in ISAPREs it is only 2%.

Table 17 shows how FONASA is the insurer of choice of high-risk and high-cost groups. For example, 93% of individuals who suffer from chronic renal failure are covered by FONASA. Both males and females over 65 years of age are also mainly covered by FONASA (77% and 80%, respectively). These are all high-risk and high-cost groups. The same can be said of children under 1 year of age and women of fertile age.

Table 17: Some information on the segmented health care system in Chile

Condition	% of the beneficiaries in FONASA
Chronic renal failure	93%
Males over 65 years of age	77%
Females over 65 years of age	80%
Children under 1 year of age	70%
Women of fertile age	76%

Source: MIDEPLAN and MINSAL, 2005

FONASA also has more young children (Table 18): 76% of the Chile's children between 0 to 4 years of age are FONASA beneficiaries (CASEN 2003). Women also concentrate in FONASA.

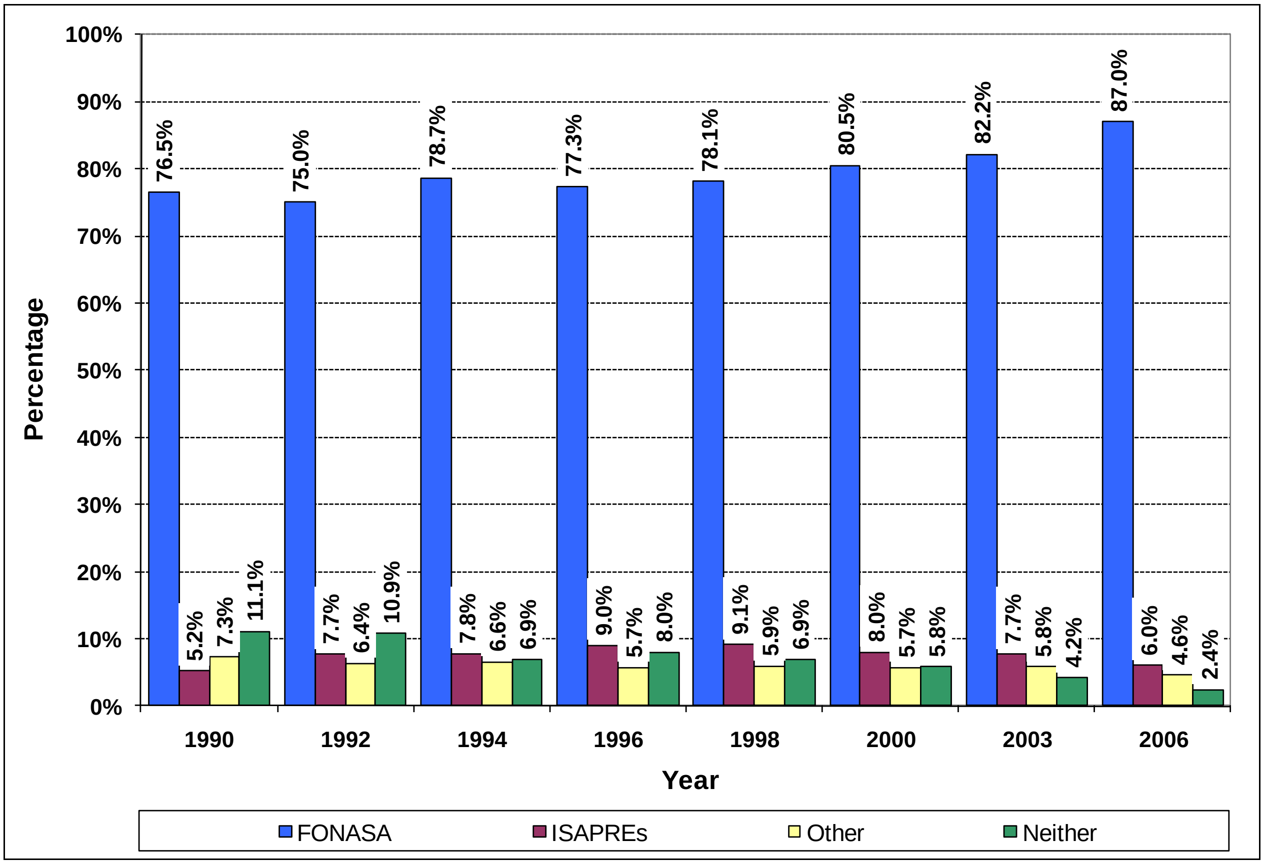
Table 18: Population distribution by insurer and age group and sex, 2003

Gender	Insurer	Age groups 00 – 04	5 – 19	20 – 39	40 – 54	55 – 69	70 +	Total
Male	FONASA	75.6	74.6	62.0	65.7	74.4	83.6	69.5
	ISAPRE	16.9	16.1	19.7	18.6	13.1	5.5	17.0
	Other Systems	6.7	8.6	16.2	14.4	11.5	9.9	12.3
	Does not know	0.7	0.6	2.1	1.2	1.0	0.9	1.2
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Female	FONASA	76.9	74.4	71.2	72.6	79.9	84.7	74.5
	ISAPRE	15.9	16.8	17.8	17.2	10.6	4.9	18.7
	Other Systems	6.6	8.1	9.8	9.4	8.8	9.2	8.9
	Does not know	0.7	0.7	1.2	0.7	0.8	1.1	1.9
	Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: CASEN 2003(MIDEPLAN, 2005).

Individuals over 60 years of age mainly use the public health system (87% are FONASA beneficiaries) (MIDEPLAN, 2008 with CASEN survey, 2006). Since 1996 there has been a sustained increase in beneficiaries over 60 years of age using the public health system (Figure 10). In contrast, this age group has decreased in importance in the ISAPREs for the same period.

Figure 10: Population over 60 years of age by insurer 1990-2006 (%)



Source: MIDEPLAN, 2008. http://www.mideplan.cl

2. Inefficiency: Risk selection

ISAPREs have incentives to select individuals by risk and income. Most ISAPREs enrol healthy, young, and high income workers and make themselves unattractive to high cost patients. Less healthy people are left in the public system because ISAPREs cream skim the wealthy and healthy. Competition between ISAPREs and the resulting risk selection give rise to inefficiency and higher costs in the Chilean health system.

The incentives to under-provide efficient preventive services, which help reduce the need for future expensive treatments, is the result of the predominance of the short term contracts (one year) favoured by competitive ISAPREs and consumers' imperfect information concerning effectiveness of services. Risk selection of low-cost enrolees decreases insurers' incentives to minimize costs and also increases administrative costs. The risk selection efforts require sales and administrative efforts, which account for 15 percent of ISAPREs' expenses between 2000 and 2007.

The private sector setting gives incentives for risk selection. ISAPREs expend less effort on improving "efficiency", and more on risk selection and "cream skimming" its portfolio. This goes against the health care social security logic and breaks pooling arrangements. Finally, efficient ISAPREs that do not select applicants may lose market share, resulting in a welfare loss to society and inefficiency. While a single ISAPRE can gain from selection, society as a whole loses. Selection produces no gains and the resources used for selection represent a welfare loss.

Risk selection and adverse selection against FONASA are two related components. When the private sector selects based on risk, this may give rise to adverse selection of individuals against FONASA. Also, different regulations applying to each system facilitate both behaviours.

Risk selection can be reflected in the composition of beneficiaries in terms of gender, age, income and risks that concentrate in FONASA.

Adverse selection against FONASA occurs when ISAPRE beneficiaries need hospital or other costly care and they decide to switch to FONASA because FONASA provides them with greater financial coverage. In the data, an indication of this behaviour could be when there are higher rates of ambulatory care and lower rates of inpatient care in the private sector in comparison to the public sector.

Adverse selection has been demonstrated empirically through various studies. Sapelli and Vial (2003) argue that there is adverse selection against FONASA because it does not have risk adjusted premiums, while ISAPREs do, which makes high risk individuals choose FONASA. The same phenomenon happens with regard to hospitalisation, even when considering individuals' self-selection effects (Sapelli and Vial, 2003). Sapelli and Vial (2003) show selection against ISAPREs for independent workers and against FONASA for dependent workers; and they show moral hazard is negligible in the case of hospitalisation.

We present new evidence that reinforces the hypothesis pointing to the presence of selection affecting FONASA, which causes individuals with higher than average expected health costs and those suffering severe illness to become join the public insurance system.

2.1. Empirical evidence of risk selection in Chile

We use a cell model to risk adjust hospital costs by sex and age, for both FONASA and ISAPREs. This is done by taking the community premium that represents all expenditures (FONASA's and ISAPREs') and adjusting it according to the hospital care expected costs of both sectors' beneficiaries in 2001. For FONASA the risk score is 1.04, while for ISAPREs it is only 0.87. These numbers assume similar prices and services between FONASA and ISAPREs, so the difference reflects the higher utilization of high-risk individuals in FONASA.

On the other hand, there is sufficient evidence to show that the ISAPREs cream skim their portfolio which allows them to have more homogeneous risks, generating lower expected costs than the national average. ISAPREs' costs are less concentrated compared to FONASA's and to the national level −which considers both FONASA and ISAPREs. In fact, assuming the same price vector, the expected costs of the private health insurance sector are lower than those for the public sector.

Table 19 shows that the system's risk, measured as the expected cost adjusted by sex and age, has been decreasing slightly from 2000 to December 2006.

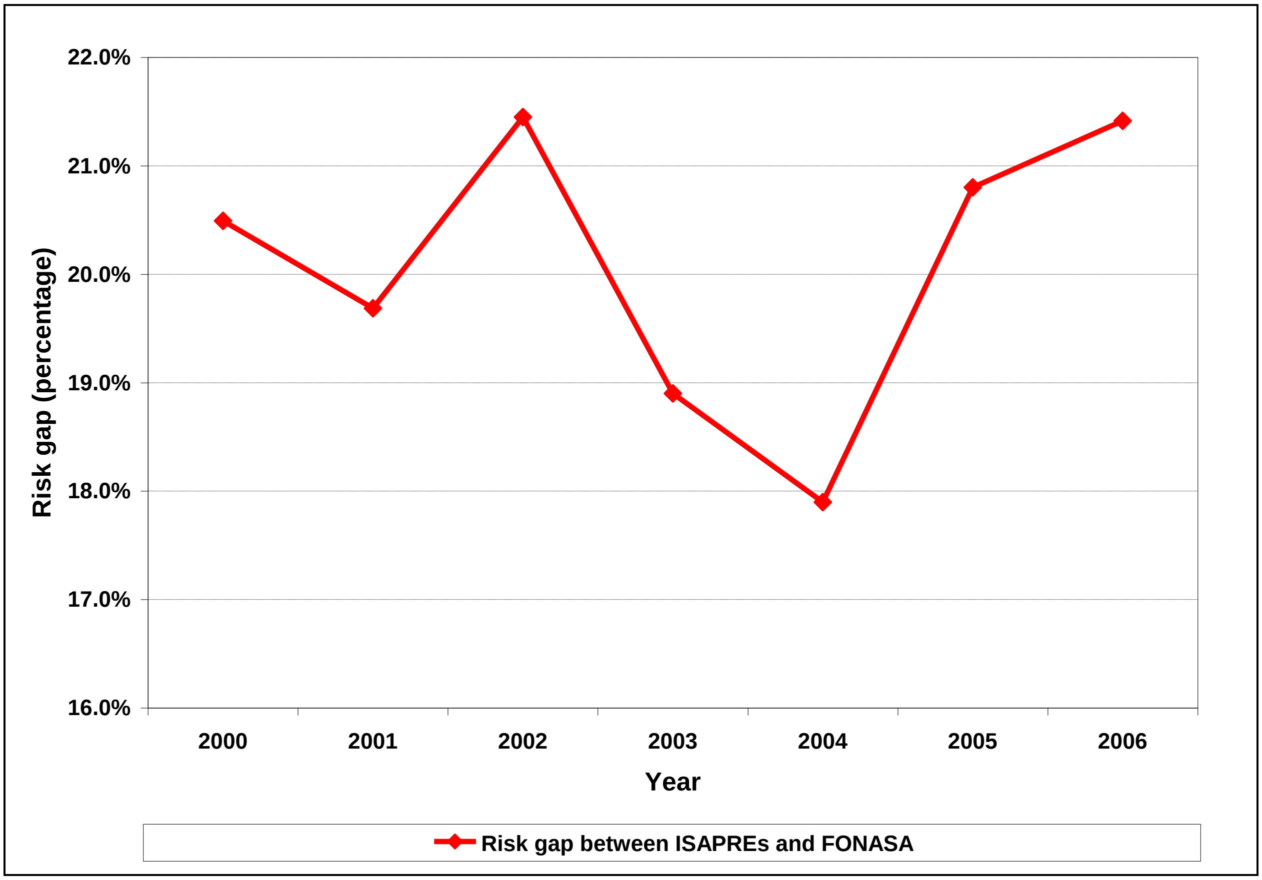
Table 19: ISAPREs and FONASA risk index, 2000-2006

	Year						
Insurer	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Colmena	0.88	0.89	0.88	0.90	0.91	0.89	0.89
Normédica	0.80	0.79	0.79	0.80	0.80	0.79	0.78
ING	0.84	0.85	0.83	0.85	0.86	0.85	0.85
VidaTres	0.87	0.90	0.89	0.91	0.92	0.91	0.91
MásVida	0.84	0.84	0.83	0.84	0.85	0.82	0.80
Banmédica	0.88	0.89	0.88	0.88	0.87	0.85	0.84
Sfera	0.73	0.74	0.74	0.75	0.76	0.76	0.75
Consalud	0.86	0.86	0.85	0.87	0.87	0.85	0.84
Fusat	0.91	0.91	0.92	0.95	0.97	0.97	1.00
Ferrosalud	1.04	1.08	1.06	1.00	1.01	0.94	0.89
ISAPREs	**0.86**	**0.87**	**0.86**	**0.87**	**0.88**	**0.86**	**0.85**
FONASA	**1.04**	**1.04**	**1.04**	**1.04**	**1.03**	**1.04**	**1.03**
Risk gap (FONASA/ISAPREs)	***20.49%***	***19.69%***	***21.45%***	***18.90%***	***17.90%***	***20.80%***	***21.41%***

Source: Author's calculations from standardized expenses of ISAPRE Systems 2005 in 36 age and sex risk groups for ISAPREs and FONASA beneficiaries. Expenses of ISAPRE System are taken from the Superintendence of Health.

In fact, Figure 11 shows the indicator of the risk gap between ISAPREs and FONASA measured as the percentage of FONASA's risk over that of ISAPREs. We computed these gaps using a cell model to adjust for sex and age using the expected costs of the GES benefits package. This first considers an equivalent community premium which is then adjusted by the expected costs of GES by sex and age. Finally, the indicator is the ratio between FONASA's risk and ISAPREs' risk.

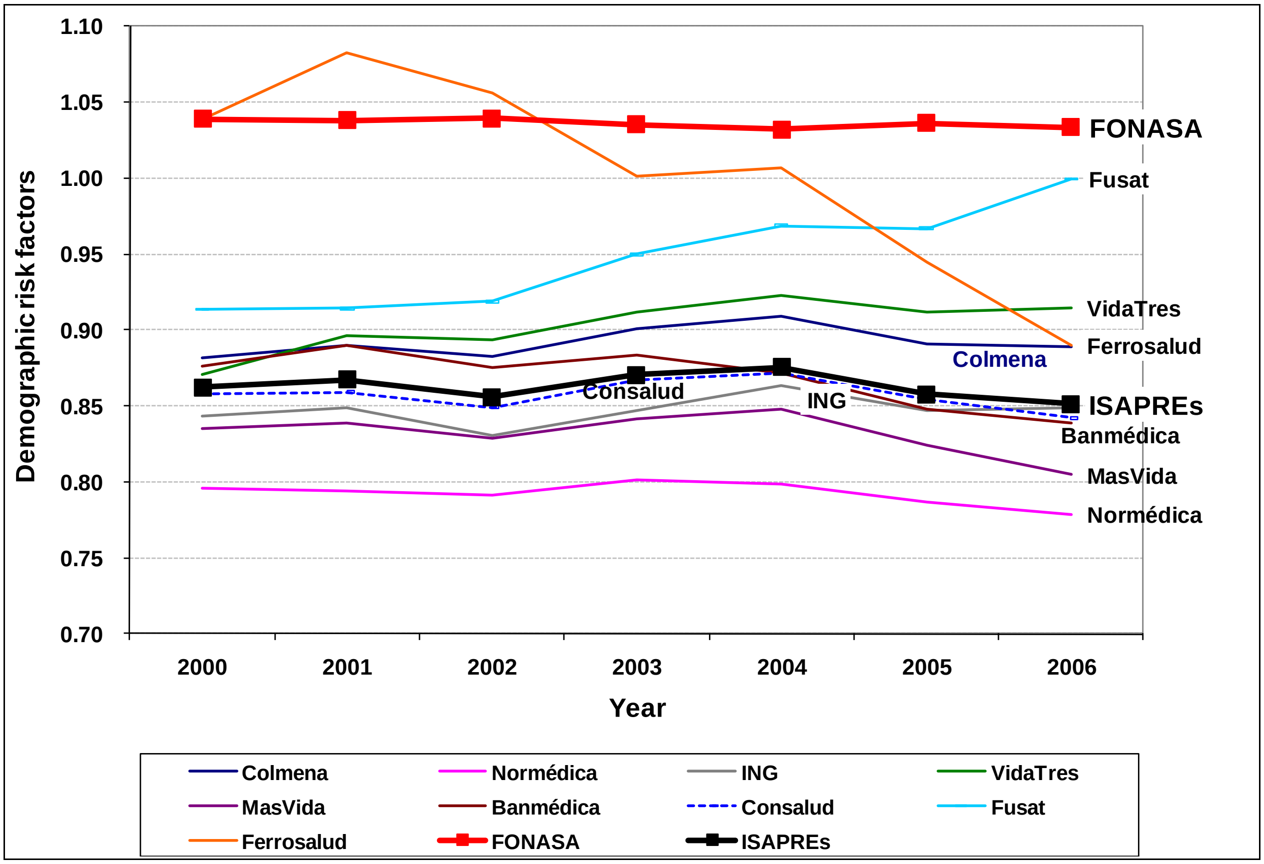
Figure 11: Risk gap between ISAPREs and FONASA, 2000-2006



Source: Author's calculations based on standardized expenses of ISAPRE Systems 2005 in 36 age sex risk groups for ISAPREs and FONASA beneficiaries. Expenses of ISAPREs are taken from the Superintendence of Health

The risk gap fluctuated between 21.5% and 18.5% during the 2000-2006 period. If we only compare 2000 to 2006, the gap increased only slightly. This means that FONASA's portfolio had a 21% higher risk than ISAPREs in December 2005. The figure also shows that the gap has two peaks, one in 2002 and the other in 2006.

Figure 12: Insurers' demographic risk, 2000-2006



Source: Author's calculations using standardized expenses of ISAPRE Systems 2005 in 36 age and sex risk groups of sex and age for ISAPREs and FONASA beneficiaries. Expenses of ISAPREs are taken from the Superintendence of Health

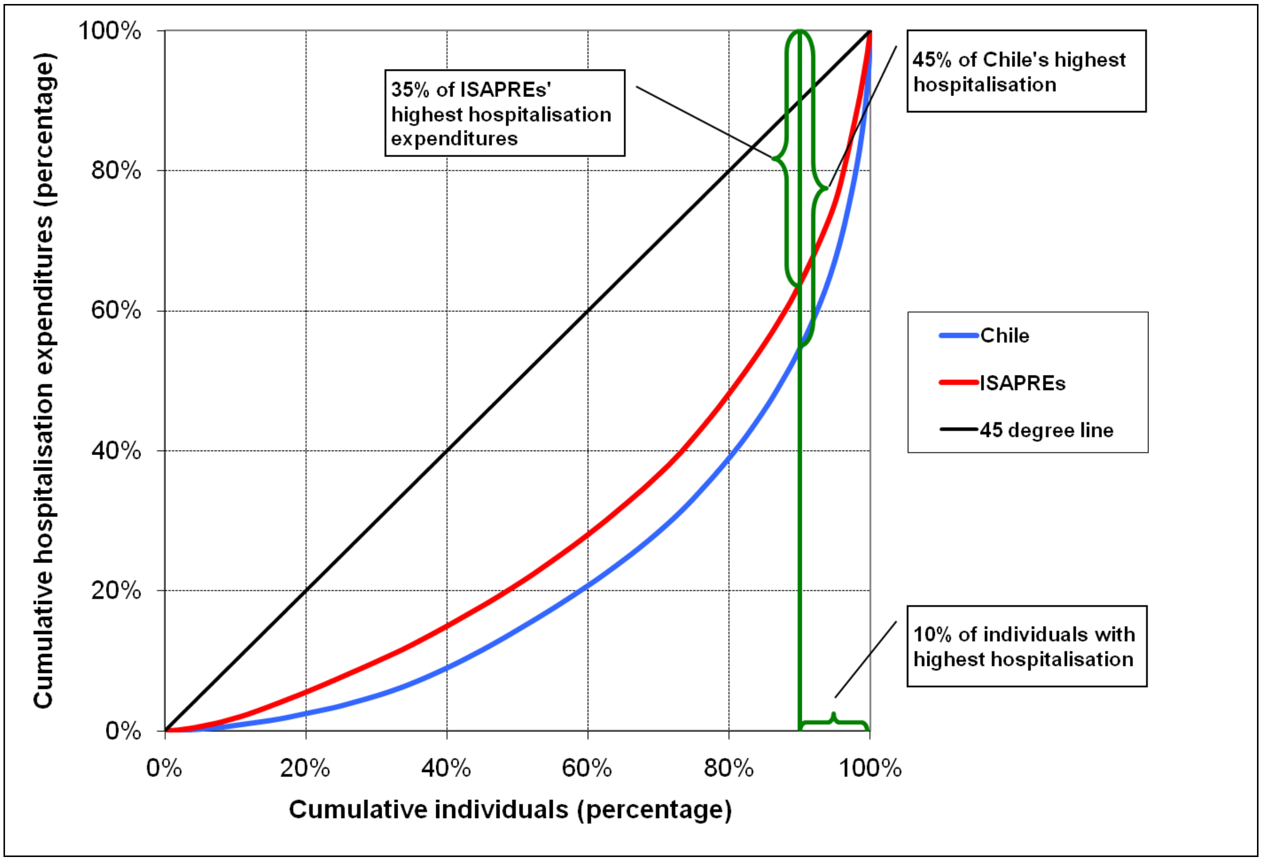
The ISAPRE system has been lowering its risk level through risk selection, and thus increasing the risk gap with FONASA. Furthermore, even though the average risk of ISAPREs has decreased, the variance across ISAPREs has actually increased.

The assumption that FONASA and ISAPREs have similar efficiency in health care provision could clearly be questioned. However, it is more likely that FONASA has high-risk individuals who require more health services than those in ISAPREs. Furthermore, we would have to argue that ISAPREs' health care management produces significant expenditure control results in comparison to the public sector. But there is no evidence of this being the case. In fact, there are very few HMO-like ISAPREs (ISAPRE Superintendence 2001). More recently, ISAPREs' beneficiaries have only used 5% of health services in GES's health care network, showing a lack of promotion from the side of ISAPREs to use these services (Superintendence of Health, 2007).

2.1.1 Risk selection and cost concentration

We argue that the public sector has higher expected expenditures as a result of the selection process against higher risk individuals. We show the Lorenz curves of the private and public systems health expenditures, and how they relate to the risk selection process.

Figure 13: Lorenz curves of hospitalisation expenditure: National versus ISAPRE



Source: Author's calculations from a sample of 5% of the discharges in 2001, ISAPRE and FONASA, with estimated costs by the author.

These curves are constructed using a sample of 5% of the data at an individual level, representing 36% of the country's overall hospital discharges. According to the cost of services provided to each individual, population percentiles are arranged from the lowest to the highest.[35]

The more costs concentrate on fewer individuals, the greater the incentives to risk select. If most costs concentrate in fewer individuals, the curve is more distant from the 45 degree line and more convex. It is also likely that the curve is less convex when insurers prevent higher cost individuals from affiliating through risk selection.

[35] Valuation of services was carried out accordingly to the principles outlined in Chapter V.

The more convex curve in Figure 13 that corresponds to national costs shows that expenditures relative to the ISAPRE system are much more concentrated in fewer people at the national level. The Gini coefficient of health expenditures in this sample is 0.57 for Chile and 0.47 for ISAPREs. The Gini coefficient was computed using the following formula (Wagstaff and van Doorslaer, 2000):

$$Gini = \frac{\sum_i \sum_j \left| x_i - x_j \right|}{\left(2N^2 \mu\right)} \tag{2}$$

where:

x_i : expenditure of person i

x_j : expenditure of person j

N : total number of individual s

μ : mean of the expenditure in the sample

Table 20: Gini coefficient of inpatient expenditure, FONASA, ISAPRE and Chile

Health Insurance System	Gini Coefficient
FONASA	0.59
ISAPREs	0.47
Chile	**0.57**

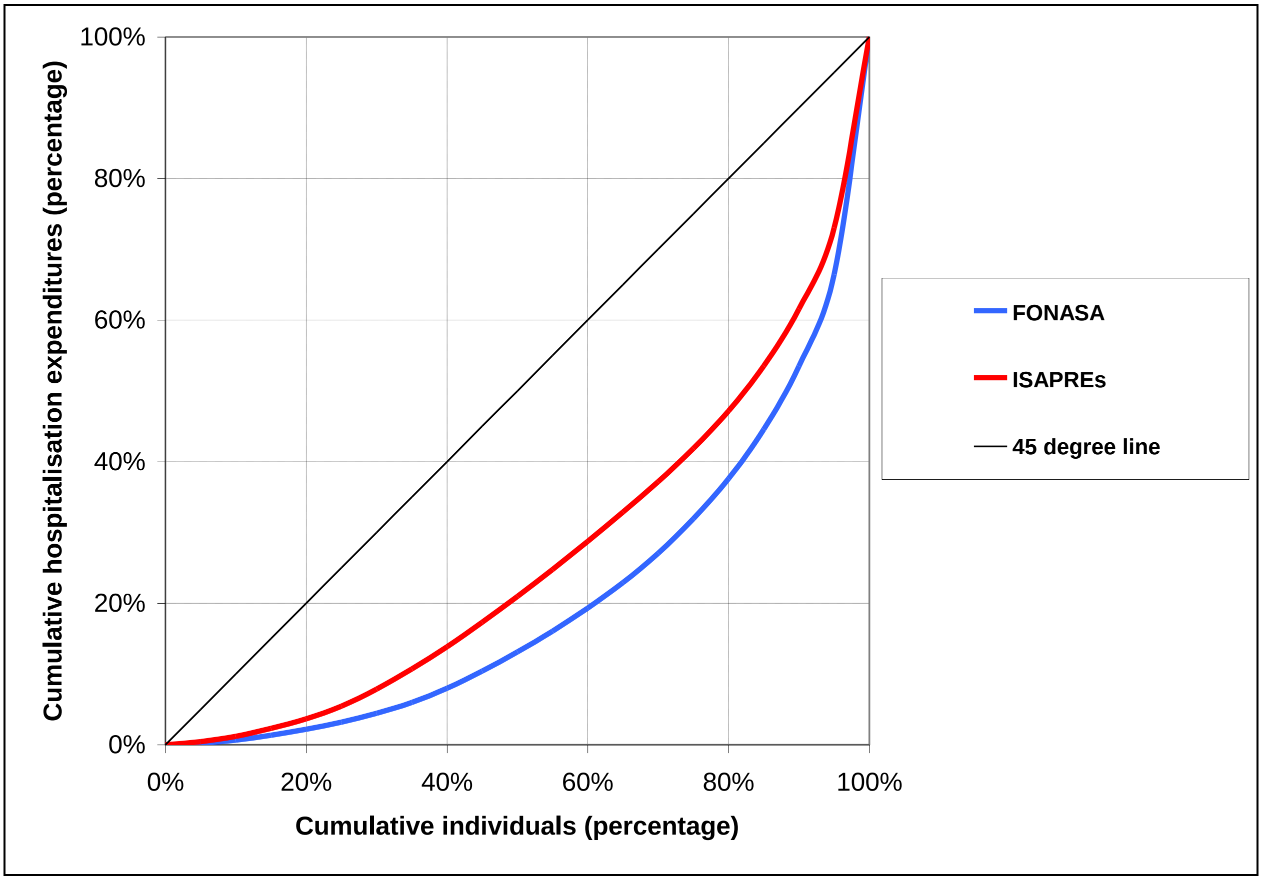
Source: Author calculations using a 5% sample of ISAPRE and FONASA discharges from 2001, with estimated costs by the author

In the case of the national costs, 45% of health expenditures concentrate in the highest 10th percentile (more costly individuals). For ISAPREs the most costly individuals represent 35% of ISAPREs' expenditures. Finally, in FONASA high cost individuals are responsible for 70% of expenditures.

The least costly individual concentrate 3.6% of national costs. In ISAPREs, 7.7% of expenditures are spent on the bottom tenth of costly individuals. Also, national expenditures are more concentrated because individuals are high risk, whereas affiliates in ISAPREs are of low risk allowing a more even distribution of expenditure.

The increase in costs in both populations (the slope of the Lorenz curves) indicates that there could be incentives for ISAPREs to select among individuals requesting affiliation and those already affiliated. Private sector expenditures increase more rapidly in the lower percentiles (up to approximately the 25th percentile) and in the last two percentiles in comparison to FONASA. At both the national level and within FONASA, expenditures increase faster in the higher percentiles (beginning at approximately the 95thpercentile). This means that ISAPREs have more incentives to select their own affiliates from those brackets than to select individuals moving out of FONASA or eventually from outside the system. These conclusions are made *ceteris paribus*, i.e., holding constant the other variables that affect individuals' health expenditures, and assuming that the utilisation rates are the same in both sectors.

Figure 14: Lorenz curves of hospitalisation expenditures: FONASA versus ISAPREs



Source: Author's calculations using a sample of 5% of ISAPRE and FONASA discharges in 2001, with estimated costs by the author.

These facts show that the public sector is covering the system's higher cost individuals and also, that in the private sector there are risk selection processes which allow it to have a more homogeneous risk distribution and, that there are incentives to continue applying this selection.

Table 21: Hospitalisation costs concentration: ISAPREs and FONASA

Percentage of individuals (from lower to higher expenditure)	Percentage of accumulated expenditure	
	FONASA	ISAPREs
0%	0.0%	0.0%
5%	0.2%	0.4%
10%	0.7%	1.2%
15%	1.3%	2.3%
20%	2.2%	3.7%
25%	3.2%	5.5%
30%	4.5%	7.9%
35%	6.0%	10.7%
40%	8.0%	13.8%
45%	10.4%	17.3%
50%	13.1%	21.0%
55%	16.1%	24.8%
60%	19.3%	28.7%
65%	22.9%	32.9%
70%	27.1%	37.2%
75%	31.9%	41.9%
80%	37.6%	47.1%
85%	44.5%	53.5%
90%	53.5%	61.6%
95%	66.5%	73.0%
100%	100.0%	100.0%

Source: Author's calculations from a sample of 5% of ISAPREs and FONASA discharges in 2001, with estimated costs by the author.

2.1.2 Consumer mobility and risk selection

In the context of risk selection, an important point is to identify and quantify the population who can freely switch between sectors. We review consumer mobility across ISAPREs, because the data available is better.

Between 2001 and 2002, 10.2% of contributors moved from one ISAPRE to another. During this same period, 11.8% of beneficiaries (contributors plus their dependents) moved from an ISAPRE to FONASA or to having no insurance (Superintendence of ISAPREs 2003). This means that approximately 40,000 beneficiaries switched systems or ISAPREs, which represented 3 to 4% of the ISAPRE population and only 0.31% of all beneficiaries (FONASA and ISAPREs). Hence, the mobility was basically restricted if we compare it to international parameters, where, for example, in Germany it fluctuates between 3 and 4% (Buchner and Wasem, 2001).

The data shows that those who switched to FONASA had lower income (about 50% lower on average) and were younger than average; these individuals pay lower contributions and have fewer dependents. First, in general, the younger population is generally more mobile. Second, the Asian crisis lowered wages and increased the risk of job loss, and because the co-payments in FONASA are significantly lower, these individuals prefer FONASA.

Table 22 presents the data on consumer mobility between July 2005 and June 2006. The total mobility across ISAPREs in this period is 7.9%. The first three columns are the sex and age distribution of the population in ISAPREs. For example, 48.51% of the women in ISAPREs are between 0 and 39 years of age. The following three columns represent the distribution by sex and age of new contributors. The new contributors are those who affiliate to any ISAPRE who were not in an ISAPRE as of June 2005. The final three columns show the movement across ISAPREs. Any person that switched ISAPRE in this period is counted. The net mobility, i.e., the amount of people switching insurance in a year, is shown in percentages.

Mobility between ISAPREs is limited by age and the existence of pre-existing disease in beneficiaries. Age is the first cause of non-mobility. For example, individuals over the age of 60 (including both men and women) almost never switch ISAPREs. However, the new contributors under 39 years of age represent 82% of the new contributor population.

Table 22: ISAPREs contributors mobility by sex and age, July 2005 and June 2006

	Total ISAPREs			New contributors			Mobility		
Age group	Female	Male	Subtotal	Female	Male	Subtotal	Female	Male	Subtotal
0 – 39	48.51%	51.05%	50.17%	80.53%	83.06%	82.22%	61.78%	63.28%	62.75%
40 – 49	24.43%	24.72%	24.62%	12.51%	12.15%	12.27%	24.59%	25.50%	25.18%
50 – 59	16.79%	15.04%	15.65%	4.85%	4.17%	4.39%	12.42%	10.00%	10.85%
60 – 69	6.88%	6.57%	6.68%	1.39%	0.58%	0.85%	1.20%	1.20%	1.20%
70 and more	3.40%	2.62%	2.89%	0.72%	0.04%	0.27%	0.01%	0.02%	0.01%
Total (%)	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Total (quantity)	**434,942**	**823,270**	**1,258,212**	**49,658**	**99,148**	**148,806**	**35,056**	**64,597**	**99,653**

Source: Author's analysis using information from the Research Department, Superintendence of Health, 2007

In a third evaluation of mobility, we consider the following variables:

1. Number of people who choose to leave an ISAPRE in a year, either due to free choice because they are seeking a better product for their money, or those who are expelled from the system. The latter cannot strictly be understood as mobility; however, it has been counted in the present exercise. The people opting out from ISAPREs are assumed to have migrated to FONASA.

2. Two indicators are generated. First, the number of people opting out from ISAPREs over the total number of people who can choose a health insurer; that is, ISAPREs plus FONASA's beneficiaries, and excluding the indigent population. This indicator shows the overall mobility. The second indicator is only for the ISAPRE system and shows the population shifting across ISAPREs as a percentage of the overall ISAPRE beneficiaries for a one-year period.

This analysis differs from the previous analyses because we do not consider FONASA group A beneficiaries (subsidized), who we assume cannot switch across systems.

The results show that the overall mobility rates vary between 2.7% and 2.1% between 2004 and 2006, with an average of 2.4% (Table 23). Mobility within the private system began at 3.4%, peaked at 5.4% in 2005 and fell back to 3.5% in 2006.

Table 23: Mobility in the Chilean Social Health Insurance System

	2004	2005	2006	Mean
ISAPREs beneficiaries	2,678,432	2,660,338	2,684,554	2,674,441
FONASA beneficiaries*	7,048,671	7,301,326	7,539,984	7,296,660
Total Beneficiaries	**9,727,103**	**9,961,664**	**10,224,538**	**9,971,102**
People moving out of the ISAPRE system	146,069	120,732	116,020	127,607
People switching between ISAPREs	90,807	144,965	94,801	110,191
Total people switching	**236,876**	**265,697**	**210,821**	**237,798**
% Mobility	***2.4%***	***2.7%***	***2.1%***	***2.4%***
% ISAPRE Mobility	***3.4%***	***5.4%***	***3.5%***	***4.1%***

* "A" beneficiaries and the indigent of FONASA are excluded
Source: Author's calculations using data from the Superintendence of Health

IV. DEMOGRAPHIC RISK ADJUSTMENT MODELS FOR CHILE

This section presents the cell −or actuarial− risk adjustment model. We begin by simulating a model similar to the one that has been applied in Chile since July 2005 with a Fund only for ISAPREs. Then, we simulate the Chilean Government's model proposed to the National Congress in 2003 (updated December 2006) with a Fund that includes FONASA.

1. Private sector risk adjustment: Solidarity Compensation Fund between ISAPREs.

This section presents the risk adjustment method applied to the Solidarity Compensation Fund only for ISAPREs between 2005 and 2007. In this methodology we consider all 56 GES health problems. We compute the value of the community premium (or solidarity contribution), the expected costs by age and sex risk groups of the Fund's beneficiary population and the premium subsidies for each risk group.

The creation of a Fund between ISAPREs had the objective of sharing health risks across ISAPRE beneficiaries for the benefits included in the GES. The Fund compensates ISAPREs for the difference between the sum of the GES community premiums and the sum of the premium subsidies (based on age and sex groups).

By law, the Fund does not apply to closed ISAPREs. These are the ISAPREs whose portfolio is mainly composed of workers and ex-workers of the company which originally formed the ISAPRE. Currently there are 6 closed ISAPREs.

In this model, the Superintendence of Health is in charge of determining the premium subsidies.

Table 24: ISAPREs participating in the Fund

ISAPRE's full name	ISAPRE's short name
Institución de Salud Previsional Fusat Ltda.	Fusat
Colmena Golden Cross S.A.	Colmena
Isapre Normédica S.A.	Normédica
ING Salud S.A.	ING
Isapre Vida Tres S.A.	Vida Tres
Ferrosalud S.A.	Ferrosalud
Isapre Masvida S.A.	Masvida
Isapre Banmédica S.A.	Banmédica
Isapre Consalud S.A.	Consalud

Source: Superintendence of Health, 2007.

The expansion of the GES benefits package has had three stages. In July 2005 an initial 25 health problems were selected. In July 2006, another 15 health problems were added to the package. Finally, in July 2007 the package added another 16 health problems, for a total of 56 health problems as initially promised with the reform.

The Superintendence of Health risk adjusts twice a year. To date, five of these exercises have taken place. The first (for the period July 2005 to December 2005) and the second (for the period January 2006 to June 2006) exercises considered 25 health problems. The third (for the period July 2006 to December 2006) and fourth (for the period January 2007 to June 2007) included an additional 15 health problems, i.e., they considered a total of 40 health problems. The fifth risk adjustment exercise (for the period July 2007 and December 2007) included all 56 health problems. The methodology and results presented here refer to the compensation of all 56 health problems currently included in GES and it was estimated for one year: July 2007 to June 2008.

1.1. Age groups

The criteria to define the sex and age groups for risk adjustment between ISAPREs were established by law. The following rules are detailed in the law:

1. The first age group begins from birth to under two years of age;

2. The next levels, from two years of age to under eighty years of age, cover a minimum of three years and a maximum of five years;

3. The Superintendence determines the corresponding levels for those of eighty years of age or more.

4. Every ten years the Superintendence reviews the maximum ratio between the lowest and highest factors in every table, differentiated by gender. (11 for male and 9 for female)

5. In every age group, the factor that corresponds to a dependent will not be higher than the factor that corresponds to a contributor of the same sex.

The Superintendence of Health also defined the following criteria:

1. **The Factor Table must be simple** to facilitate transparency in plan offerings both for the insurers and for the insured. To this end the Table was limited to a predefined number of rows.

2. **The Factor Table must follow a health logic**, such that the age groups are those used for health indicators and people's life cycle.

3. There must be **symmetry between GES and the Complementary Plan**. For example, it is always possible for a GES user to not use the GES to get medical care for a GES pathology and instead to use the Complementary Plan. On the other hand, it is expected that in the long run the GES Plan should include most of the burden of disease.

Furthermore, following from above and after a suggestion made by this author, 18 age groups were defined, conforming 36 risk cells or categories –hereon after denominated "risk groups". Table 25 presents these risk groups. This age group structure complies with the above mentioned requirements.

Table 25: Generic risk age and sex risk groups

	Sex	
Age range	Males	Females
0 – 1 year of age		
2 – 4 years of age		
5 – 9 years of age		
10 – 14 years of age		
15 – 19 years of age		
20 – 24 years of age		
25 – 29 years of age		
30 – 34 years of age		
35 – 39 years of age		
40 – 44 years of age		
45 – 49 years of age		
50 – 54 years of age		
55 – 59 years of age		
60 – 64 years of age		
65 – 69 years of age		
70 – 74 years of age		
75 – 79 years of age		
80 years of age and older		

Source: Superintendence of Health.

1.2. Estimating compensations

In this section we determine the community premium and the subsidy premiums that ISAPREs receive for their beneficiaries from the Fund.

1.2.1 The approved risk adjustment model

As we pointed out in Chapter II, the Inter-ISAPREs risk adjustment model approved by the Chilean Congress is known in the international literature as an ex-ante system. It uses information of previous periods to estimate the subsidies for the community premium, reflected in the risk adjusted premiums (Wasem, 2003). Therefore, the payments are independent of the real costs of the period being compensated.

Notwithstanding, the model applied is combined with information about the beneficiary population at the moment of each adjustment period. Hence, the value of risk adjusted premiums is re-calculated with the purpose of avoiding break downs of the Fund, but the relative relationship between the risk factors is preserved (Cid et al, 2007).

This type of model preserves the efficiency incentives, since the adjusted premiums are calculated based on the averages of all insurers and not of any one in particular. It also tends to be more equitable, because it compensates for the health risk of beneficiaries at the moment of adjustment. On the other hand, the premium subsidies do not vary significantly when readjusting for the beneficiary population, basically because the beneficiary composition maintains certain stability.

1.2.2 Sources of information

We use the reference costs for health services or groups of health services to determine the community premium. We use GES data to obtain the frequencies in ISAPREs of the 56 health problems prioritised.

The reference costs per GES are published by MINSAL based on external cost studies (Universidad de Chile, 2006; MINSAL, 2007). These reference costs must be used by the Inter-ISAPREs Fund, so we use them here as well. The study requested by MINSAL computes these reference costs as a weighted average of the public and private sector costs of providing health care services.

To estimate the number of GES cases in the ISAPREs, we combined different sources of information.

The treatment of GES health problems has a predefined structure.[36] The health problem is separated into three stages: diagnostic, treatment, and follow-up. In each stage there is a list of

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[36] Many of the GES conditions reflect the use of procedure information, not simply diagnoses. Similarly to DRG payments, the Chilean risk adjustment formula uses a combination of health status information (diagnoses) and treatment practice information (procedures). We only use the significant procedures.

health services. We then estimate the frequency of occurrence by age and sex groups within these stages.

We use the existing estimates of the number of cases of each service or groups of services associated with the GES health problem, and for each risk group, that are based on the methodology in MINSAL's Decree.[37] We complement this with the reference cost information by considering the type of health intervention, the value assigned to the services or groups of services and the co-payments stipulated by law.

The Superintendence is in charge of estimating the frequencies.[38] The Superintendence estimated the GES health problems' utilization frequencies for the ISAPRE system, disaggregated by groups of health problems. As such, there are estimates of the number of cases for the first 25 health problems and the number of cases for the additional 15 health problems. For the remaining 16 health problems we use two sources: for hospitalisations we use the Master files of Hospital Leaves and of Medical Services in the ISAPRE system of the year 2004 and 2005 (Superintendence of Health); and for the majority of ambulatory care we use well-known rates of incidence and prevalence in the country, provided by MINSAL.

We use the beneficiary population in the ISAPRE system in February 2007 to compute the community premium and the expected costs by age groups and sex. Finally, for the simulation of the annual compensations, i.e., the cumulative monthly payments, the last available month was used for all the months in the sample, that is, the beneficiary population from March 2007 to February 2008.

[37] To date, 3 decrees have been issued by MINSAL: N°170 for 25 problems of health (July 2005 to June 2006), N°228 increasing the number of health problems to 40 (July 2006 to June 2007) and N° 44 expanding the GES to include 56 health problems (July 2007 to June 2010).

[38] The author worked with the Superintendence to compute these estimations, jointly with clinical and statistics professionals. We include only the final results in this research.

1.2.3 Method and calculations of Inter-ISAPRE risk adjustment

1.2.3.1 Determination of the community premium[39]

The estimated annual costs for each GES health problem are shown in Table 26.

Table 26: Estimated annual expenses of the 56 GES problems (US dollars Dec. 2007)

#	Health problem	Expenditure per year (USD)	Cases per year	% of total expenditure	% of total cases
1	Terminal chronic renal insufficiency	3,514,232	382	5.46%	0.27%
2	Surgically feasible congenitalcardiopathies in patients younger than 15 years old	2,446,243	339	3.80%	0.24%
3	Cervical and uterine cancer	1,306,591	1,000	2.03%	0.71%
4	Pain relief in advanced cancer and palliative care	95,133	305	0.15%	0.22%
5	Acute myocardial infarction	273,172	873	0.42%	0.62%
6	Diabetes mellitus type 1	1,802,661	1,933	2.80%	1.38%
7	Diabetes mellitus type 2	2,988,537	18,016	4.64%	12.83%
8	Breast cancer in 15 year-old persons and older	3,842,467	1,688	5.96%	1.20%
9	Spinal dysraphism	33,280	15	0.05%	0.01%
10	Surgical treatment of scoliosis in patients younger than 25 years old	1,439,119	171	2.23%	0.12%
11	Surgical treatment of cataract	1,611,544	1,653	2.50%	1.18%
12	Total hip endoprosthesis in 65 year-old persons and older with hip arthrosis and severe functional limitation	1,039,810	196	1.61%	0.14%
13	Labiopalatal fissure	73,692	37	0.11%	0.03%
14	Cancer in patients younger than 15 years old	1,618,953	116	2.51%	0.08%
15	Schizophrrenia	390,693	150	0.61%	0.11%
16	Testicular cancer in 15 year-old persons and older	2,099,586	282	3.26%	0.20%
17	Lymphomas in 15 year-old persons and older	1,617,934	226	2.51%	0.16%
18	Acquired immune deficiency syndrome - HIV/aids	4,720,613	607	7.33%	0.43%
19	Low acute respiratory infection, outpatient treatment, in children younger than 5 years old	53,491	11,286	0.08%	8.04%
20	Pneumonia acquired in community, outpatient treatment, in 65 year-old persons and older	3,951	123	0.01%	0.09%
21	Primary or essential arterial hypertension in 15 year-old persons and older	1,569,104	33,646	2.44%	23.96%
22	Non refractive epilepsy in persons from 1 year old up to 15 year-olds	43,636	307	0.07%	0.22%
23	Integral oral health for 6 year-old children	416,565	7,541	0.65%	5.37%
24	Prematurity	184,579	427	0.29%	0.30%
25	Pulse generation and conduction disorders in 15 year-old persons and older requiring pacemaker	1,359,417	382	2.11%	0.27%
26	Cholecystectomy preventing gallbladder cancer in symptomatic patients between 35 and 49 years old	720,540	919	1.12%	0.65%
27	Gastric cancer	1,131,113	139	1.76%	0.10%

[39] For details on this computation review the reference in footnote number 4.

Table 26: Estimated annual expenses of the 56 GES problems (US dollars Dec. 2007)

#	Health problem	Expenditure per year (USD)	Cases per year	% of total expenditure	% of total cases
28	Prostate cancer in 15 year-old persons and older	3,783,478	909	5.87%	0.65%
29	Refractive errors in 65 year-old persons and older	27,233	830	0.04%	0.59%
30	Squint (strabismus) in children younger than 9 years old	111,475	509	0.17%	0.36%
31	Diabetic retinopathy 1	440,300	739	0.68%	0.53%
32	Non-traumatic rhegmatogenous retinal detachment	179,493	153	0.28%	0.11%
33	Hemophilia	613,715	77	0.95%	0.05%
34	Depression in 15 year-old persons and older	5,071,355	28,771	7.87%	20.49%
35	Surgical treatment of benign prostate hyperplasia in symptomatic persons	276,095	263	0.43%	0.19%
36	Orthosis (or technical aids) for 65 year-old persons and older	4,459	44	0.01%	0.03%
37	Ischemic cerebrovascular accident in 15 year-old persons and older	463,730	490	0.72%	0.35%
38	Chronic obstructive pulmonary disease of outpatient treatment	133,645	1,162	0.21%	0.83%
39	Moderate and severe bronchial asthma in patients younger than 15 years old	427,230	4,135	0.66%	2.94%
40	Respiratory distress syndrome in newborns	1,336,731	133	2.07%	0.09%
41	Medical treatment in 55 year-old persons and older with light or moderate knee and/or hip arthrosis	187,061	4,481	0.29%	3.19%
42	Subarachnoid hemorrhage secondary to brain aneurysm rupture	1,202,647	433	1.87%	0.31%
43	Surgical treatment of primary tumors of the central nervous system in 15 year-old persons and older	1,354,587	894	2.10%	0.64%
44	Surgical treatment of lumbar disk herniation (nucleus pulposus)	588,170	601	0.91%	0.43%
45	Leukemia in 15 year-old persons and older	920,292	1,030	1.43%	0.73%
46	Outpatient dental emergency	10,261	784	0.02%	0.56%
47	Integral oral health in 60 year-old adults	489,184	1,367	0.76%	0.97%
48	Severe polytraumatized patient	2,790,639	295	4.33%	0.21%
49	Emergency care in severe or moderate cranio-encephalic traumatism	4,580,389	1,411	7.11%	1.00%
50	Severe eye trauma	21,887	23	0.03%	0.02%
51	Cystic fibrosis	77,443	8	0.12%	0.01%
52	Rheumatoid arthritis	2,085,464	3,431	3.24%	2.44%
53	Drug and alcohol abusive consumption and dependence in persons younger than 20 years old	199,838	1,284	0.31%	0.91%
54	Labor analgesia	104,424	3,028	0.16%	2.16%
55	Burned patients	398,335	40	0.62%	0.03%
56	Bilateral hypoacusia in 65 year-old persons and older who require earphones	145,207	348	0.23%	0.25%
	Total	64,421,422	140,432	100.00%	100.00%

Source: Prepared by the Research and Development Department, Superintendence of Health.

Each one of these health problems are disaggregated into groups of health care services in the three stages mentioned above (diagnosis, treatment and follow up). For example, consider the first health care problem: terminal chronic renal insufficiency. In this case the annual cost shown in Table 26 was computed based on Table 27 below.

Table 27: Example of estimated annual expenses for the 56 GES problems (US dollars)

Nº	Health problem or program	Health services or group of health services	GES fee	Co-payment	GES fee without co-payment	Number of cases per year
1.-	TERMINAL CHRONIC RENAL INSUFFICIENCY	*Peritoneal dialysis in patients younger than 15 years old*	1,297	259	1,037	7
		Hemodialysis	994	199	795	3,516
		Simple Vascular Access (through FAV) for Hemodialysis	646	129	517	32
		Complex Vascular Access (through FAV) for Hemodialysis	1,217	243	974	6
		Implant of Temporary Catheter for Hemodialysis	141	28	113	8
		Implant of Temporary Long term or Tunnelled Catheter for Hemodialysis	789	158	631	1
		Endovenous Ferrum for patients in dialysis	43	9	34	1.788
		Erythropoietine for patients in dialysis younger than 15 years old	174	35	139	46
		Study of Pre-Transplant receptor	732	146	586	10
		Kidney Transplant	8,602	1,720	6,881	9
		Immunosuppression drug protocol 1	33	7	26	367
		Immunosuppression drug protocol 2	493	99	394	321
		Immunosuppression drug protocol 3	1,254	251	1,003	413

Source: Superintendence of Health http://www.supersalud.cl

Once we have the number of annual cases per service or group of services for each of the 56 GES health problems, we multiply them by the reference cost, without considering any co-payment. We obtain the total expenditure of the 56 GES health problems adding the previous products, according to formula (3) below:

$$TC = \sum_{i=1}^{n} RT_i \times Q_i \tag{3}$$

$where:$
TC : Total costs
RT_i : Reference fee of GES' benefit i
Q_i : Number of cases of GES' benefit i

So, first, Table 28 presents the beneficiary population of the ISAPREs participating in the Fund as of February 2007.

Table 28: ISAPREs beneficiary population participating in the Fund by age and sex group

Age group	Males	Females	Total
00-01	35,931	33,360	69,291
02-04	62,612	59,231	121,843
05-09	113,992	108,564	222,556
10-14	115,990	109,597	225,587
15-19	116,218	105,715	221,933
20-24	127,999	90,124	218,123
25-29	131,174	99,385	230,559
30-34	137,888	114,900	252,788
35-39	124,120	108,263	232,383
40-44	112,647	104,491	217,138
45-49	92,565	92,929	185,494
50-54	70,829	75,962	146,791
55-59	53,480	56,194	109,674
60-64	36,296	36,225	72,521
65-69	18,502	19,494	37,996
70-74	10,599	11,547	22,146
75-79	6,771	7,664	14,435
80 +	4,502	6,523	11,025
Total	**1,372,115**	**1,240,168**	**2,612,283**

Source: Author's calculations using information from the Superintendence of Health.

Table 29 presents total costs.

Table 29: Summary of the Community Premium calculation for the 56 GES problems

Item	Amount
Expenditure on the 56 GES health problems per year (in US dollars)	64,421,422
Number of ISAPREs beneficiaries (9 ISAPREs)	2,612,283
Annual community premium (in US dollars)	**24.66**
Monthly community premium (in US dollars)	**2.06**

Source: Author's calculations using information from the Superintendence of Health

Furthermore, the Community Premium is defined as the contribution that every ISAPRE beneficiary gives the Fund; it is equivalent to the actuarial annual cost per capita of the 56 GES problems (formula (4)).

$$CP = \frac{\sum_{i=1}^{n} RT_i \times Q_i}{B} \tag{4}$$

$where:$

CP : Community premium

RT_i : Reference fee of GES' benefit i

Q_i : Number of cases of GES' benefit i

B : Number of ISAPREs beneficiaries participating in the Fund

So, the Annual Community Premium is US$ 24.66, equivalent to a Monthly Community Premium of US$ 2.06[40] (Table 29).

Note that the estimation of the Community Premium assumes that all individuals diagnosed with a GES problem participate in the GES system through the ISAPREs' health provider network. This allows us to estimate potential demand. But, we know that some people prefer to use their complementary plan[41] instead of GES, either because their preferred providers are not registered

[40] These figures contain decimals, for the reasons stated in the notes for Charts 4 and 5. Furthermore, the Community Premium is shown in Chilean current pesos, since the Fee established in the Decree is in said currency.

[41] Here we divide ISAPREs' health plans into two parts: the GES benefits package and all other benefits included in the "complementary plan."

in their plan or because they have a sufficiently high financial coverage so as to not need the GES financial protection.

1.2.4 Risk factors or standardized expected costs

Table 30 shows the estimates of total costs of the GES problems for each risk group. It shows the total expenditure by age and sex groups −considering 56 GES problems− and the magnitude of the contributions of every risk group. The total annual cost is US$ 64.4 million, where women represent 46% and men 54% of the total cost. The estimated annual per capita cost for each of the 36 risk groups is the estimated costs divided by the beneficiary population.

Table 30: Total estimated expenses for 56 GES problems by age groups

Age groups	Males	Females	Total
00-01	1,500,393	1,722,461	3,222,854
02-04	607,621	489,239	1,096,861
05-09	1,323,502	920,001	2,243,503
10-14	1,239,601	1,551,571	2,791,171
15-19	1,122,654	1,100,194	2,222,848
20-24	1,136,102	1,140,266	2,276,368
25-29	1,505,985	1,278,385	2,784,370
30-34	2,293,860	1,830,186	4,124,046
35-39	2,337,102	2,199,061	4,536,163
40-44	2,701,942	2,897,155	5,599,097
45-49	2,664,726	3,180,876	5,845,603
50-54	2,822,377	3,091,785	5,914,162
55-59	3,045,723	2,727,152	5,772,876
60-64	3,135,587	2,320,203	5,455,791
65-69	2,334,667	1,584,247	3,918,914
70-74	1,779,967	1,211,399	2,991,366
75-79	1,366,048	840,568	2,206,616
80 +	766,173	652,641	1,418,814
Total	**33,684,031**	**30,737,391**	**64,421,422**

Source: Author's calculations using information from the Superintendence of Health

The formula to compute the risk factors for each risk group is given by:

$$RF_j = \frac{\sum_{i=1}^{n} RT_i \times q_{ij}}{b_j \times CP} \quad (5)$$

where :

RF_j : Risk factor of risk group j

RT_i : Reference fee of benefit i

q_{ij} : Frequency of use of benefit i by risk group j

b_j : Number of beneficiaries in risk group j

CP : Community premium (average)

Notice that the risk factors are normalised by the average estimated costs for each risk group, because we divide the per capita costs of a risk group by the community premium.

As we can see from formula (5), we need to know the specific frequency of each health service (benefit) by sex and age groups. We show how we obtain these frequencies through an example. Continuing the example of terminal chronic renal insufficiency, Table 31 presents the frequencies disaggregated by sex and age. There were a total of 367 cases between July 2005 and June 2006.

Table 31: Example of frequency of benefit by sex and age for one GES health problem

Health condition: terminal chronic renal insufficiency – Target of population: All ISAPRE beneficiaries

	Cases of terminal chronic renal insufficiency			Population			Rate*10000		
Age groups	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
00-01	1	-	1	35,931	33,360	69,291	0.28	-	0.14
02-04	-	-	-	62,612	59,231	121,843	-	-	-
05-09	3	3	6	113,992	108,564	222,556	0.26	0.28	0.27
10-14	2	3	5	115,990	109,597	225,587	0.17	0.27	0.22
15-19	7	-	7	116,218	105,715	221,933	0.60	-	0.32
20-24	7	6	13	127,999	90,124	218,123	0.55	0.67	0.60
25-29	3	2	5	131,174	99,385	230,559	0.23	0.20	0.22
30-34	7	4	11	137,888	114,900	252,788	0.51	0.35	0.44
35-39	16	9	25	124,120	108,263	232,383	1.29	0.83	1.08
40-44	18	11	29	112,647	104,491	217,138	1.60	1.05	1.34
45-49	16	11	27	92,565	92,929	185,494	1.73	1.18	1.46
50-54	26	19	45	70,829	75,962	146,791	3.67	2.50	3.07
55-59	35	23	58	53,480	56,194	109,674	6.54	4.09	5.29
60-64	30	17	47	36,296	36,225	72,521	8.27	4.69	6.48
65-69	20	11	31	18,502	19,494	37,996	10.81	5.64	8.16
70-74	19	8	27	10,599	11,547	22,146	17.93	6.93	12.19
75-79	14	3	17	6,771	7,664	14,435	20.68	3.91	11.78
80 +	11	2	13	4,502	6,523	11,025	24.43	3.07	11.79
Total	**235**	**132**	**367**	**1,372,115**	**1,240,168**	**2,612,283**	**1.71**	**1.06**	**1.40**

Source: Author's calculations using information from the Superintendence of Health

The table above counts number of cases of a specific health problem. We then restructure the table to show the number of cases of a specific health intervention –haemodialysis− by sex and age groups.

Table 32: Example of frequency by sex and age of one service for one GES Health problem: Haemodialysis in terminal chronic renal insufficiency

Age groups	Male	Female	Total
00-01	9.2	-	9.2
02-04	-	-	-
05-09	27.1	27.3	54.4
10-14	18.2	27.2	45.4
15-19	66.4	-	66.4
20-24	66.7	57.3	124.0
25-29	29.5	19.1	48.5
30-34	65.7	36.5	102.2
35-39	152.2	83.4	235.6
40-44	168.4	100.3	268.7
45-49	153.4	103.0	256.4
50-54	251.3	182.5	433.8
55-59	333.7	218.7	552.5
60-64	292.4	166.0	458.4
65-69	196.9	107.2	304.1
70-74	176.8	75.7	252.5
75-79	139.7	29.6	169.3
80 +	114.8	20.1	134.9
Total	**2,262.3**	**1,253.8**	**3,516.1**

Source: Author's calculations using information from the Superintendence of Health

So, the 367 individuals who presented the health problem (Table 31) used approximately 3,516.1 haemodialysis in a year. This must then be added to the other services covered under this GES problem (Table 27) to obtain the total number of services as in Table 32 by sex and age groups.

Once we have the frequencies by age and sex groups we can compute risk factors. Table 33 below shows the normalised risk factors.

Table 33: Risk factors for the 56 GES problems (Average=1)

Age groups	Males	Females
00-01	1.6933	2.0937
02-04	0.3935	0.3349
05-09	0.4708	0.3436
10-14	0.4334	0.5741
15-19	0.3917	0.4220
20-24	0.3599	0.5130
25-29	0.4655	0.5216
30-34	0.6746	0.6459
35-39	0.7635	0.8237
40-44	0.9726	1.1243
45-49	1.1673	1.3880
50-54	1.6158	1.6505
55-59	2.3093	1.9679
60-64	3.5031	2.5972
65-69	5.1168	3.2954
70-74	6.8098	4.2541
75-79	8.1809	4.4474
80 +	6.9010	4.0571

Source: Author's calculations using information from the Superintendence of Health.

Risk groups having factors higher than 1 are those whose estimated costs are higher than the average; risk groups with factors lower than 1 are those whose estimated costs are below average.

1.2.4.1 Premium subsidies

We use formula (6) to compute premium subsidies, which is simply the product of the community premium and the corresponding risk factor (taken from Table 31).

$$RAP_j = CP * RF_j \tag{6}$$

$where:$

RAP_j : Risk adjusted premium for risk group j

CP : Community premium

RF_j : Risk facot of risk group j

In this case, the weighted average risk factor of the portfolio is 1, since it refers to the risk distribution of February 2007. Table 34 shows the Premium Subsidies for February 2007 for the ISAPREs participating in the Fund.

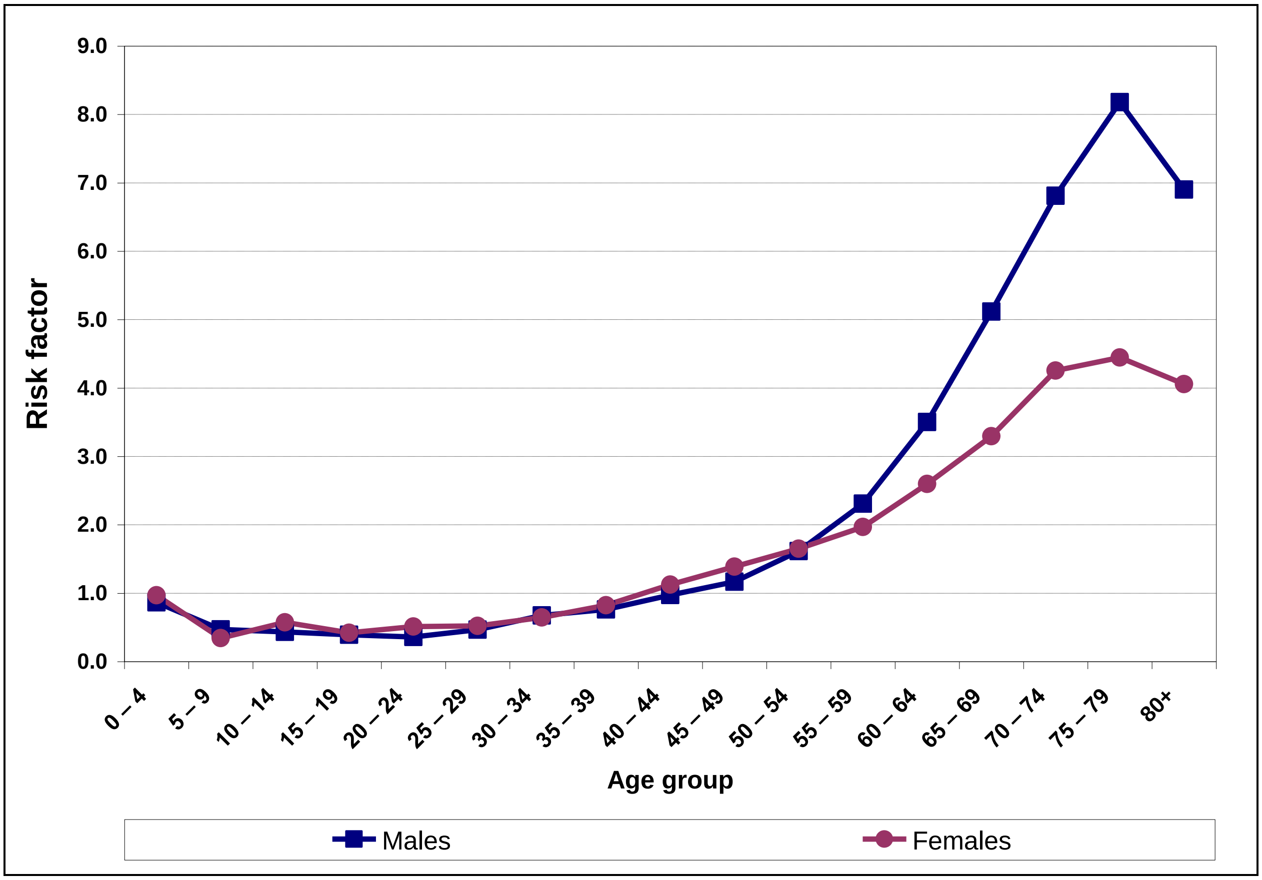
Table 34: Annual premium subsidies by risk groups (beneficiaries of February 2007)

Age groups	Males	Females
00-01	41.76	51.63
02-04	9.70	8.26
05-09	11.61	8.47
10-14	10.69	14.16
15-19	9.66	10.41
20-24	8.88	12.65
25-29	11.48	12.86
30-34	16.64	15.93
35-39	18.83	20.31
40-44	23.99	27.73
45-49	28.79	34.23
50-54	39.85	40.70
55-59	56.95	48.53
60-64	86.39	64.05
65-69	126.18	81.27
70-74	167.94	104.91
75-79	201.75	109.68
80 +	170.19	100.05

Source: Author's calculations using information from the Superintendence of Health

Figure 15 presents the risk factors by sex and age for individuals with ISAPREs. Notice that mainly those over 39 years of age have a risk factor greater than the average (greater than 1) and all age groups over 50 years of age are above the average. For women over 70 years of age the risk factor stabilizes, unlike the case of men whose risk factor keeps increasing until it becomes more than 8 times the average (the women's risk factor reaches only almost 4 times the average). Thus, the gender difference is significant for those above 65 years of age, where the expected costs are much higher for men.

Figure 15: ISAPREs risk factors for the 56 GES health problems (Average = 1)



Source: Author's calculations.

One might have expected significant gender differences in the women of fertile age (15-49 years of age), but the absence of childbirth and other related problems in the 56 GES health problems eliminates this expected difference. The same happens with the children under one year of age, despite the presence of congenital heart diseases and the problems of pre-adulthood. This happens because of the low frequency of these problems in the ISAPRE system relative to other problems included in the 56 GES health problems, when considering its ambulatory and hospital aspects.

In sum, persons under 40 years of age contribute for adults over 60 years of age. This means that the Fund is fulfilling a basic rule of intergenerational solidarity in terms social security policy.

Since we computed risk factors with ex-ante information of the beneficiary population (February 2007), it is natural that, if it is applied to a new population the Fund may become exposed. Note also that it is a requisite that the Fund be exact at all times, so that it is necessary to normalise the risk factor table to the risk of the current beneficiary population distribution.

1.2.4.2 Determination of the compensations

Compensations between the ISAPREs depend on two concepts: the financial power (FP) and the financial need (FN) of each ISAPRE with respect to the GES.[42]

We compute financial power as:

$$FP_i = CP * B_i \tag{7}$$

$$\begin{aligned} &\textit{where}:\\ &\quad FP_i : \text{Financial Power of ISAPRE } i\\ &\quad CP : \text{Community premium}\\ &\quad B_i : \text{Total number of beneficiaries in ISAPRE } i \end{aligned}$$

We compute financial need as:

$$FN_i = \sum_{j=1}^{36} PS_j * b_{ij} \tag{8}$$

$$\begin{aligned} &\textit{where}:\\ &\quad FN_i : \text{Financial Need of ISAPRE } i\\ &\quad PS_j : \text{Premium subsidy for risk group } j\\ &\quad b_i : \text{Number of beneficiaries in ISAPRE } i \text{ in risk group } j \end{aligned}$$

The difference between these two variables defines the compensations, in such a way that:

If $FP_i > FN_i$, ISAPRE *i* pays a compensation to one or more ISAPREs;

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[42] These concepts were taken from the German risk adjustment model (in Buchner and Wasem, 2003).

If $FP_i < FN_i$, ISAPRE *i* receives a compensation from one or more ISAPREs; and,

If $FP_i = FN_i$, ISAPRE *i* does not pay or receive resources from the Fund.

Thus, the net compensation of each ISAPRE is given by the following formula:

$$NC_i = FP_i - FN_i \tag{9}$$

where:

NC : Net compensation

FP : Financial power

FN : Financial need

Provided that:

$$\sum_{i=1}^{n} NC_i = 0 \tag{10}$$

That is to say, the Fund empties (zero sum compensation).

1.2.5 Summary of results

1.2.5.1 Fund resources

The Fund requires approximately US$ 64.4 million annually (Table 30). Men represent 52% of these resources and women represent 48%.

1.2.5.2 Net compensations

Net compensations −the resources actually redistributed within the ISAPRE system− sum US$ 1.15 million a year (see Table 36 below). This is equivalent to 1.8% of total Fund resources.

Each ISAPRE contributes in accordance with its financial power, and receives in accordance with its financial need.

1.2.5.3 Contributing and Recipient ISAPREs

Transferred resources can be analysed by grouping ISAPREs as contributing or recipient ISAPREs. Contributing ISAPREs have smaller risks than the average and the sum of their contributions to the Fund are higher than the sum of their risk adjusted financial needs (FP > FN). Recipient ISAPREs have higher risks than average and their contributions to the Fund are lower than their risk adjusted financial needs (FP < FN).

In general, the largest relative risk that recipient ISAPREs exhibit is due to a lesser proportion of children (resource contributors) and a bigger proportion of elders (resource recipients) in their respective beneficiaries' portfolios, in relation to the average population of the system (Figure 15).

Table 35: Relative risk of participating ISAPREs in the Solidarity Fund

ISAPRE	Relative risk score	% Children 15 or less	% Adults 60 or more
Colmena	1.043	24.80%	7.00%
Normédica	0.871	28.50%	2.80%
ING Salud	0.987	24.60%	5.60%
Vida Tres	1.096	24.30%	8.10%
MasVida	0.878	28.30%	2.80%
Banmédica	0.989	23.60%	6.30%
Consalud	1.003	23.70%	6.00%
Fusat	1.338	21.10%	13.70%
Ferrosalud	1.054	23.50%	6.60%
ISAPREs' average	**1.000**	**24.50%**	**6.10%**

Source: Author's calculations

For example, ISAPRE Colmena has above average relative risks because its beneficiary population includes an above average number of older adults. This makes it a recipient ISAPRE, i.e., it should receive compensatory resources. ISAPRE MasVida is another example: it has below average relative risks, because it has an above average proportion of children and a below average proportion of elderly. In this case, MasVida is a net contributor.

Table 36: Annual transfers between ISAPREs: contributors and recipients

Contributing ISAPREs			Recipient ISAPREs		
ISAPRE	**US dollars**	**%**	**ISAPRE**	**US dollars**	**%**
MasVida	655,641	57%	Colmena	409,242	36%
Banmédica	174,672	15%	Fusat	339,181	29%
ING Salud	162,544	14%	Vida tres	330,431	29%
Normédica	159,437	14%	Consalud	43,778	4%
			Ferrosalud	29,662	3%
Total	**1,152,294**	**100%**	**Total**	**1,152,294**	**100%**

Source: Author calculations

In sum, the ISAPREs that contribute are: Normédica, ING Salud, MasVida and Banmédica; while the ISAPREs that receive these contributions are Colmena, Vida Tres, Fusat, Ferrosalud and Consalud.

1.2.5.4 Benefited risk groups

In general, the individuals who receive subsidies to their premiums through risk adjustment are those over 35 years of age, men over 30 and women over 35 with the exception of women aged 40-44. In terms of total amounts, the net distribution for women is 63% that of men.

Men clearly contribute more than women but, after the adjustment, they turn out to be beneficiaries in a higher proportion than their own contributions relative to the case of women. The age group that make greater contributions is the 10 to 14 year old group, for both men and women. Those that receive more are70 to 74 year old men and women aged 65 to 69.

Clearly, in this stage, the Fund shows intergenerational solidarity.

1.2.6 Comments about this risk adjustment model

This subsection presents the first estimation of the financial effects of the Fund in the ISAPRE system, for the selected year, with the available information and the methodology presented above.

The Fund is a regulatory tool for the private insurance sector to prevent risk selection. In the case presented here, we incorporate 56 GES problems, and the discrimination towards elderly people, whose expected costs are significantly higher than the average, is directly targeted.

Out of the nine ISAPREs that participate in the risk adjustment system, four are contributors and the five are recipients, representing 35% and 65% of the beneficiaries, respectively.

Out of the US$ 64.4 million that the Fund collected in 2007, only US$ 1.14 million, or 1.8%, was redistributed.

Contributions are quite different (uneven), and do not correspond to the size of the portfolios nor to their proportion relative to the total beneficiaries. For example, Normédica contributes 14% and its portfolio is only 2.1% of the total pool of beneficiaries. ING contributes 14% of the transfers and its portfolio represents 22%. MasVida contributes 57% and its portfolio is 7.3%. This is the result of the risk differences across portfolios.

It is clear that what influences these redistributions is the relative amount of children and elderly that each ISAPRE may have at the moment the compensation is made.

If we analyse the Fund's redistribution in terms of risk groups, we have seen that, given the 56 priorities, initially the Fund benefits mainly the elderly and among them a greater number of men than women. Notwithstanding, in the medium term this should change, if childbirth and pregnancy are included which would benefit women of fertile age as well as young children.

Redistribution is quite moderate, at a rate of US$ 0.44 per average benefit per year, which represents 1.8% of the GES average premium and 0.076% of the operational income of the system.

It is important to note that the incentives that come with risk adjustment depend on the amounts involved. As such, the effect the Fund and risk adjustment would have is directly related to the number and price of the problems incorporated in GES. At the current time, its effects are moderate. These are estimates for the current portfolio, but the Superintendence expects the Fund's structure to allow for the portfolio to become more homogenous in time (Superintendence of Health, 2007) with regards to the previous system and to the national population in such a way that the amount to compensate should diminish in relative terms in the same measure that the distribution of risks becomes more homogenous in the ISAPRE system.[43] Nevertheless, this could be questioned. The experience in Germany and Switzerland is that they do not become homogenous – and as long as health status is not in the formula, those insurers who are most active in risk selection manage to keep a healthy membership (van de Ven et al., 2007).

Risk adjustment introduces progressiveness and with the current model, there is redistribution towards the elderly and children under one, whose expected costs are significantly above average.

The extent to which incentives work and generate desired effects depends on the amount of resources in the Fund. We use the prices established by law and published by MINSAL (which are a weighted average of the public and private sectors) to compute compensation amounts, since it is not the scope of this research to compute real costs.[44]

Demographic adjustment transfers are made towards ISAPREs whose enrolees have relatively high income. This happens because some ISAPREs have specialized in older, healthy and high-income individuals −for example, ISAPRE Colmena− and because of risk selection. Finally, the model's ability to predict costs should increase if it were a regression model with more variables including health status of the beneficiaries and observed costs of the health interventions.

The most important problem of this system is that this fund cannot adequately correct the risk selection problems because it does not include FONASA. Basically ISAPREs can still select the good risks and send the bad risks to FONASA, which means that FONASA subsidizes the private system.

Moreover, the effect of the Fund is still too limited and requires urgent changes in the model to avoid the unwanted effect of reallocating resources to ISAPREs with a large number of persons

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[43] To the extent that the number of health problems included in GES increases, the incentives to homogenize risk will also increase.

[44] In June 2006, when there were 25 health problems included in GES, the author estimated that the prices published by MINSAL were undervalued by approximately 50% relative to actual costs using the data from the Superintendence (Cid and Muñoz, 2007).

over 65 years of age who are still healthy and who are of high income (for example, ISAPREs Colmena and VidaTres) and also strengthen the incentives against risk selection.

2. Demographic risk adjustment for public (FONASA) and private (ISAPREs) health systems

This section describes the methodology behind the Government's original proposal presented to Congress. We simulate the operation of the Fund that distributes health risk adjusted premium subsidies based on the estimates of expected expenditure by sex and age using a cell model. We include FONASA and we use the estimated GES cost (US$ 93.56) as our community premium, but we maintain the risk factors used in the previous model.

2.1. Method for demographic risk adjustment model including FONASA

In this subsection we present the methodology to estimate the key values in the demographic risk adjustment model that includes FONASA. We begin with the relative per capita costs and then proceed with the solidarity contribution. We then obtain the premium subsidy and the total value of premium subsidies per insurer. From this exercise we can estimate the net transfers across main insurance systems (FONASA and ISAPRE).

2.1.1 Methodology in previous studies of relative costs by sex and age groups

In Vargas, Cid, et al., 2005, the formula to calculate relative costs by sex and age sums all hospitalisations and outpatient expenditures for all users by sex and age groups. They then divide by the total population of beneficiaries of FONASA and ISAPREs in each sex and age group. They estimate relative costs of the GES guaranteed benefits at the hospital level using the 41 GES benefits that include hospital services and that are associated with over 400 International Classification of Diseases, 10th Revision (ICD-10) codes in the hospital discharge database for 2001. They then associate these codes to unit costs of GES benefits calculated, specifying 41 prices for hospitalisation per day and 33 prices for surgery associated to one GES hospitalisation episode. Total hospitalisation costs by sex and age groups are then grouped into 5-year periods.[45]

The method in Vargas, Cid et al., 2005, considers only hospital care. We compute the risk adjustment considering ambulatory and hospital care costs of the 56 GES health problems. We use the estimated costs in the studies requested by the MINSAL (Bitrán et al., 2006; Universidad de Chile, 2007).

The hospital day price is multiplied by the number of days of stay in the hospital and an amount for surgery expenditure was added per episode when appropriate. Expenditure per discharge was aggregated by age and sex group and divided by the total number of FONASA and ISAPRE beneficiaries, resulting in a per capita cost of GES guaranteed benefits by sex and age groups.

We use a different methodology than the one presented above to compute premium subsidies by risk groups, because we need the relative costs that consider both the private and the public sector. In sum, we use the solidarity contribution computed by MINSAL in 2003 that considers both sectors and the risk factors of the 56 GES problems presented in section 1 of this chapter, which are the more recent values available for Chile.

2.1.2 Solidarity contributions to the Fund

Solidarity contributions or community premiums to the Fund are obtained by multiplying the universal GES premium contribution calculated by the Reform Commission for the public sector −approximately US$ 93.56 per capita − by the number of persons insured. In addition, the Government pays for universal premium of all FONASA indigent beneficiaries and a supplementary amount for those FONASA beneficiaries whose contribution are not enough to cover their own and their dependants’ universal premium. The Government contribution is equal to US$ 93.56 per indigent.

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[45] The more differentiated the risk groups, the fairer the system. However, greater differentiation makes the model more complex and estimates less stable. Therefore, a balance has to be reached between advantages and disadvantages.

Table 37: Solidarity contributions to the Fund (population and US dollars 2006)

Insurer	Gender	Total premium contributions	Beneficiaries
FONASA	Male	530,075,033	5,665,760
	Female	543,908,837	5,813,624
	Total	***1,073,983,871***	***11,479,384***
ISAPREs	Male	131,510,675	1,405,665
	Female	119,649,814	1,278,889
	Total	***251,160,489***	***2,684,554***
Total	Male	661,585,708	7,071,425
	Female	663,558,651	7,092,513
	Total	***1,325,144,359***	***14,163,938***

Source: Author's analysis.

FONASA[46] and ISAPREs pay solidarity contributions to the Fund. The Fund collects US$ 1.33 billion, where 81% comes from FONASA and 19% from ISAPREs.

2.1.3 Standardized expected costs and premium subsidies

The value of the premium subsidy results from multiplying the value of the solidarity contribution by the values of the normalized expected costs by age and sex groups (table of risk factors). By multiplying the per capita value of the subsidized premiums by sex and age of the respective FONASA and ISAPRE beneficiary population, we get the total sum of subsidized premiums that each insurer receives, assuming that the Fund redistributes 100% of the solidarity contributions.

2.2. Standardized expected costs

The normalized expected costs or risk factors are derived from the per capita costs, by sex and age, of the benefits package that is standardized by transforming the average per capita cost to 1.

Consistent with international results, the elderly tend to have more health needs than younger people. The same occurs when women of fertile age are compared to men in the same age group.

[46] FONASA's contributions include fiscal transfers.

The risk factors “favours” older people. Men over 40 and women over 45 are ‘more expensive’ that the average person, but more so in the case of men.

2.2.1 Premium subsidies

The following table shows the amounts of the risk premiums subsidies for the 34 age and sex groups.[47]

Table 38: Value of the premium subsidies

Age groups	Subsidized premium for males	Subsidized premium for females	Mean
00 – 04	81.16	90.62	85.74
05 – 09	44.05	32.15	38.24
10 – 14	40.54	53.71	46.94
15 – 19	36.65	39.48	38.00
20 – 24	33.67	48.00	39.59
25 – 29	43.56	48.80	45.82
30 – 34	63.11	60.43	61.89
35 – 39	71.43	77.06	74.05
40 – 44	91.00	105.19	97.83
45 – 49	109.21	129.86	119.56
50 – 54	151.17	154.41	152.85
55 – 59	216.06	184.11	199.69
60 – 64	327.74	242.99	285.41
65 – 69	478.71	308.31	391.29
70 – 74	637.11	398.00	512.44
75 – 79	765.39	416.09	579.93
80+	645.64	379.57	488.22
Mean	**93.13**	**94.03**	**93.56**

Source: Author’s analysis.

2.2.2 Distribution of the total amount of premium subsidies

The age and gender distribution between FONASA and ISAPREs is shown in the following table:

47 For this simulation we group 0 −1 year of age in the 0 – 4 age group because FONASA’s population information does not include that specific age group.

Table 39: ISAPRE and FONASA beneficiary population, 2006 (December)

Age Groups	FONASA			ISAPRES		
	Male	Female	Total	Male	Female	Total
00 – 04	437,760	419,017	856,777	100,982	95,129	196,111
05 – 09	480,386	447,895	928,281	117,298	111,776	229,074
10 – 14	542,274	504,868	1,047,142	119,870	113,475	233,345
15 – 19	509,485	458,267	967,752	120,433	109,955	230,388
20 – 24	454,040	447,906	901,946	131,333	93,306	224,639
25 – 29	412,147	416,480	828,627	131,452	100,414	231,866
30 – 34	399,604	410,220	809,824	139,400	116,990	256,390
35 – 39	425,684	431,415	857,099	124,970	110,471	235,441
40 – 44	415,344	401,430	816,774	115,243	107,569	222,812
45 – 49	342,639	348,682	691,321	94,576	95,667	190,243
50 – 54	289,768	299,330	589,098	73,223	78,635	151,858
55 – 59	232,272	244,911	477,183	56,154	58,575	114,729
60 – 64	218,528	263,523	482,051	38,099	37,702	75,801
65 – 69	185,370	225,457	410,827	19,175	20,335	39,510
70 – 74	137,869	185,387	323,256	11,086	12,361	23,447
75 – 79	97,079	146,070	243,149	7,203	8,584	15,787
80+	85,511	162,766	248,277	5,168	7,945	13,113
Total	**5,665,760**	**5,813,624**	**11,479,384**	**1,405,665**	**1,278,889**	**2,684,554**

Source: FONASA and Superintendence of Health

The redistribution of the total amount of the Fund, in accordance with the present risks of beneficiary populations of each insurer, is as follows:

Table 40: Contribution to the Fund and distribution from the Fund to FONASA and ISAPREs beneficiaries (in US dollars 2006)

Insurer	Gender	Resource distribution from the Fund
FONASA	Male	573,972,734
	Female	552,846,245
	Total	***1,126,818,979***
ISAPREs	Male	103,425,917
	Female	94,899,464
	Total	***198,325,381***
Total	Male	677,398,650
	Female	647,745,709
	Total	***1,325,144,359***

Source: Author's analysis.

Aggregate figures per institution show that the Fund reassigns 49% of the resources to women and 51% to men.

Finally, by adding the monetary values by sex and age groups it is possible to identify the insurers that are net contributors to the Fund. If we compare the contribution with the financing and distribution of the Fund, we can see that in this simulation there is a net transfer of resources in favour of FONASA. Under the assumption that the sum of premium contributions of FONASA is US$ 1.07 billion, US$ 52.8 million is redistributed from the ISAPREs as a result of the greater risk index of the public institution. This transfer is equivalent to 4% of the Fund's resources.

This compensation model benefits FONASA, although it is still less beneficial in comparison to the one that incorporates diagnoses in a DxCG regression model (see Chapter V).

V. Data and methods for diagnoses-based risk adjustment

1. Data for diagnoses-based risk adjustment in Chile

This part of the study is developed mainly with the dataset of hospital expenditures for Chile in 2001. The dataset has systematic and reliable information about the Chilean system since the 1970s and it includes all the hospital care providers, including SNSS (public system provider–NHS type), private clinics, mutual insurance hospitals and armed forces hospitals. The dataset covers beneficiaries of all the health insurance systems.

Although the data has been collected since the 1970s, it was temporarily discontinued in the 1980s, and later recovered in 1992 and 1996; from the year 2000 on it has been re-established, and the more recent datasets are for 2001, 2002 and 2003. But due to quality problems, we have selected the year 2001 for the main estimations and the year 2003 to run robustness tests.

1.1. Year 2001 discharges dataset and GES benefits package

The dataset has a total of 1,566,187 records (discharges). The dataset is made up of 38.5% men and 61.5% women, with patients ranging in age from 0 to 112. The children under one year of age represent 6.7 % of the cases. Also, 1.4% of the records are not classified by insurance. Table 41 presents the insurance type composition.

Table 41: Hospital discharges distribution by affiliation of health

Insurance system	Number of discharges	Discharges as percentage of the total
FONASA	1,114,300	71.1%
ISAPRE	245,553	15.7%
None	62,884	4.0%
Others	121,343	7.7%
Without classification	22,107	1.4%

Source: Author's analysis from Discharges 2001 Data Set http://www.minsal.cl

The diagnoses are identified with the WHO's four-digit ICD-10 coding system and all expenditures can be attributed to 7,319 different codes. Ten codes represent 21.6% of the diagnoses and five codes represent 14.6%. There are 34.1% of discharges with surgery and

62.2% without surgery. The remaining 3.9% of the observations have missing values in the surgery variable.

GES guarantees 42 health problems that add up to 441,214 discharges and correspond to 32.5% of FONASA and ISAPREs' expenditures. In this dataset three GES conditions, out of the 41 GES health problems that include services at the hospital level, cover most of the diagnoses and cases: accidents requiring Intensive Care Units (ICU) includes 101 diagnoses; emergency with life at risk includes 85 diagnoses; and all cancers in children under 15 years of age includes 84 diagnoses (Frenz et al., 2003).

From this list, most of the GES health problems are guaranteed to the entire population, with the following exceptions for treatments guaranteed only to certain age groups:[48]

- All cancers in children under 15, totalling 84 diagnoses (three-digits)
- In all ages stomach cancer (2 diagnoses), biliary tract cancer (2 diagnoses), cancer of the uterus (5 diagnosis), breast cancer (2 diagnoses), testicular cancer (2 diagnoses), prostate cancer (1 diagnosis).
- Cholecystotomy for women 40-years of age (4 diagnoses)
- Lymphomas, tumours and cysts for those over 15 (7 diagnoses)
- Leukaemia for those over 15 (6 diagnoses)
- Tumours and cysts for those over 15 years of age(5 diagnoses)
- Cataracts for those over 65 and under 2 (4 diagnoses)
- Pneumonia in those over 65 (6 diagnoses)
- Prosthesis for those over 65 (5 diagnoses)
- Depression in women over 15 (2 diagnoses)
- Drug and alcohol dependency for those between 15 and 19 years of age (2 diagnoses)
- Strabismus for those under 9 (2 diagnoses)

[48] This information was elaborated by the Reform Commission of the Chilean MINSAL

1.2. Method for cost estimation in the discharges dataset

The 2001 data of hospital discharges includes imputed expenditures of public and private providers in Chile. Every row of the dataset represents a discharge and it includes the identification of the Regional Health Service, the hospital code, the patient identifier (with ID−only 36%), number of the clinical record, demographic and provisional characteristics (sex, age, county of residence and type of insurance), the clinical diagnoses of hospitalisation registered at the end of the hospitalisation period in ICD-10 codes, days of hospitalisation, condition of discharge (live or dead dummy), clinical service, surgical intervention, etc.

Unlike the previous chapters, here we use a regression model that requires data at the individual level. We use the dataset to compute the cost of each discharge and then aggregate per individual to estimate an individual's hospital care cost and diagnostic history in 2001. Because the discharge costs are not assigned directly by each hospital, we had to compute them ex-post based on several periodic FONASA and MINSAL cost studies for public sector hospitals.

We imputed costs using the FONASA, Bitrán et al., 1996 method, although there are new studies and new costs that are being used especially for GES. Therefore in this study, three complementary studies were used to impute costs of discharges for the 2001 dataset: FONASA, Bitrán et al., 1996, Reform Commission and MINSAL (2001 and 2003) and Rodríguez et al., 2003. The following sections describe the methods used to assign costs.

1.2.1 Method for cost estimations in all diagnoses except GES diagnoses[49]

In our regression model, we represent all health problems because we want the best cost estimate that captures all the hospital morbidity. This means we consider risk adjustment for all health services −GES and non-GES− and this requires estimating costs for all health services.

In Chile, FONASA uses two types of prices to transfer money to Health Services, which in turn distributes resources to hospitals:

[49] Ministerio de Salud & FONASA, "Equidad en el Financiamiento del Seguro Público de Salud", Informe Final, Volume 2 and Annex A of Volume 3. Authors: Bitrán R., Muñoz J., Navarrete M., Aguad P., Ubilla G. See Annex for details about this method.

One of them is the price of PAD "*Pago Asociado a Diagnósticos*" (Payments Associated with Diagnosis), which are 25 packaged costs (similar to DRGs[50]), differentiated into 3 classifications according to hospital complexity. The other is the price of PPP "*Pago Por Prestación*" (Payments for service or fee-for-service payments), which are values of the task associated with health services not grouped into packages of resolution. At the hospital level the task PPP has values for the different services.

Variables including the name of the hospital, clinical service inside the hospital, days of stay, type of bed, surgery (when performed) and diagnosis of discharge are used to calculate the costs for 2001, according to the PAD-PPP transfer prices.

The first method has two procedures:

a) **Procedure 1**: If the discharge diagnosis was included in 75 PADs (differentiated into three types of hospital categories: Type I; Type II; and Type III and IV), then it was assigned that value of the PAD. 25% of discharges fell into this category.

b) **Procedure 2**: If the discharge diagnosis was not a PAD diagnoses, then the following procedure was used for compute cost:

1. The cost composition of 75 PADs (25 packaged costs times three types of hospitals), was broken down into three components:
    - Examinations and procedures;
    - Surgical interventions; and
    - Bed days.
2. We denoted the percentage of PADs costs corresponding to examinations and procedures as the "Expansion Factor of Examinations and Procedures" (EFEP).

[50] Each PAD has associated to a determined set of ICD-9 codes. To translate the codes to ICD-10, we used the crosswalk table of the German Institute of Medical Documentation and Information (DIMDI Germany at http://www.dimdi.de).

3. Then each discharge was matched to the most similar PAD using as criteria the most similar diagnosis of the PAD package, according to the medical criteria in FONASA, Bitrán et al., 1996. Then, we used the EFEP of the selected PAD to calculate the discharge cost following formula (11).

4. The cost of the surgical intervention component was determined according to the surgical components of the task PADs or PPPs. We matched the discharge to the most similar surgical intervention or to several types of surgeries to obtain a representative cost.

5. The bed day cost was based on the clinical service and severity level of each discharge, which was obtained from the task PADs and PPPs and from the FONASA 2002 costs study.

6. Correction factors for teaching providers and distant areas were applied (these are fixed by law).

7. Finally, we computed the total discharge cost based on the following formula:

$$TDC = \left[\left(NBD \times BDC\right) \times \left(1 + EFEP\right) + SC\right] \tag{11}$$

$where$:
TDC : Total discharge cost
NBD : Number of bed days
BDC : Bed day cost by clinical service and severity
$EFEP$: Expansion Factor of examinations and procedures
SC : Surgery cost

1.2.2 Method for cost estimation for GES diagnoses[51]

This method incorporates the cost calculations of the health problems considered in the GES Plan. Rodriguez et al., 2003, separate the MINSAL's GES calculations (MINSAL, 2002) to identify the different levels of care: ambulatory and hospital. They calculate a daily value for

[51] Rodríguez et al., 2003, Comisión de Reforma 2001, Comisión de Reforma –MINSAL 2003.

every GES diagnosis, only for the hospital level. It is necessary to note that the GES costs were based on the FONASA-PADs when possible, but they also incorporate ambulatory primary and secondary care that the PADs do not address.

The decision on the cost range used to obtain a value for GES Package's health provisions and packages used various criteria based on the public sector's current operational costs, such as human resources, equipment maintenance and infrastructure (MINSAL, 2002). All of these services are represented in FONASA's classification for both GES modalities, that is, the Institutional Health Care Modality (MAI) and the Free Choice Health Care Modality (MLE), both governed under the following rules:

1. When estimates for demand coverage[52] expansions are below 20% of the present coverage, the MAI tariff was used. We assume that an increase public demand does not require and increase in the installed capacity and that these prices reflect the public sector's production structure and capacity. 25% of the hospital plan expenditure is based on this criterion.

2. When estimated coverage expansions are over 20% of present coverage, or present supply restrictions come into consideration, a 30% increased MAI was used. About 49% of GES's hospital expenditure is based on this criterion.

3. For new programs, without packages currently in use, the FONASA free choice (MLE) tariff was utilized for each individual provision. About 25% of the Plan's overall cost is based on this criterion.

4. Complementing the preceding criteria, we considered two special cases for estimated coverage expansions: when it represented of 20% of demand and when there were supply restrictions. In the first case, we used a weighted average of MAI and MLE to calculate

[52] The GES's total cost was computed as the sum of total health care services provided (used as a proxy for demand) multiplied by their respective average cost. GES's total cost was estimated at approximately $550 billion pesos. When comparing estimated demand with actual demand coverage for GES's 56 problems, some gaps called "coverage expansions" are observed.

the price, while in the second case we used market prices. These two cases only represent 1% of GES's hospital care costs.

5. Basic coverage was estimated based on the public sector's per capita expenditure (this method is not relevant to this study).

We impute these costs to the 2001 discharges dataset using the following procedure. MINSAL produced a list of ICD-10 codes associated with GES, including around 6200 four-digit codes. Subsequently, it produced a second version of the ICD-10 codes associated to the guaranteed GES at a hospital level using the hospital discharge database corresponding to the year 2001, which includes more than 400 ICD-10 three-digit codes.

Then, the Reform Commission estimated unit costs of GES diseases by disaggregating services by service level: inpatient, outpatient and primary health provisions. These estimates were derived as a first attempt to estimate the total cost of the GES's 56 diseases and conditions using a 'normative' methodology. In this methodology, average protocols for a disease are identified and then multiplied by the unit costs, and the total annual cost per patient was computed. This allows us to identify the hospital bed day cost for 41 GES's diseases.

We take these bed day prices and multiply them by the number of days of stay in a hospital. An amount for surgery expenditure was added per episode whenever appropriate. The formula we used is as follows:

$$TDC = \left(NBD_e \times BDC_{diag}\right) + SC_{diag} \tag{12}$$

$where$:

TDC_{diag} : Total diagnostic cost

BDC_{diag} : Bed day cost in accordance with the discharge diagnosis associated to one of the 41 AUGE health problems at the hospital level

NBD_e : Number of bed days

SC_{diag} : Lump - sum value per episode in accordance with the diagnosis when there is surgery, otherwise it is equal to 0

We use both Bitrán and FONASA 1996 and MINSAL-GES's costs in this study. So, we use the methodology GES 2002 and 2003 when costing is related to GES's expenditure, and the Bitrán- and FONASA 1996 methodology otherwise.

Both methodologies are considered similar; while the GES methodology is more sophisticated, there are no other cost studies as comprehensive as the one for GES.

1.3. Beneficiary populations

These simulations use the 2001 beneficiary population. The beneficiary population in 2001 of each insurer is identified, broken down into sex and age groups, and organized in two large blocks: FONASA population and ISAPRE population (Table 42). Over 10 million people are beneficiaries of the public sector and less than three million are beneficiaries of the private system. Beneficiaries from the Armed Forces and individuals without insurance have been excluded from this calculation. The number of men in ISAPREs is slightly higher than women, whilst women are more numerous than men in FONASA. There are more people over 65 years of age registered in FONASA than in ISAPREs. Finally, it is important to note the high coverage of ISAPREs during the more economically active years of the population −between 30 to 45 years of age (Table 15)− when they have higher expected income. These patterns have a direct effect on the differentiated risk factor between FONASA and ISAPREs.

Table 42: ISAPRE and FONASA beneficiary population, 2001

Age Groups	FONASA			ISAPREs		
	Females	Males	Total	Females	Males	Total
00-4	451,459	465,191	916,650	126,862	135,343	262,205
05-09	453,979	476,978	930,957	142,644	150,277	292,921
10-14	446,943	468,918	915,861	139,123	144,884	284,007
15-19	414,186	421,985	836,171	110,949	115,841	226,790
20-24	388,936	385,481	774,417	102,913	121,726	224,639
25-29	383,536	386,239	769,775	130,336	144,827	275,163
30-34	387,399	389,328	776,726	137,583	145,284	282,867
35-39	390,634	382,480	773,114	135,992	139,814	275,806
40-44	346,867	343,999	690,865	118,821	114,629	233,450
45-49	285,273	287,463	572,735	96,954	89,028	185,982
50-54	239,617	232,332	471,949	74,379	70,649	145,028
55-59	208,693	184,670	393,363	54,801	52,927	107,728
60-64	167,133	140,886	308,019	31,882	31,838	63,720
65-69	195,125	159,135	354,260	18,278	17,631	35,909
70-74	163,259	121,994	285,253	12,181	10,899	23,080
75-79	121,216	74,299	195,515	6,466	5,196	11,662
80 +	128,050	64,005	192,055	6,358	3,480	9,838
Total	**5,172,304**	**4,985,383**	**10,157,686**	**1,446,522**	**1,494,273**	**2,940,795**

Source: FONASA and Superintendence of Health

1.4. Getting data for diagnoses-based risk adjustment

From the total discharges dataset in Chile for 2001 we developed a sub-sample dataset with 541,969 specific individuals (with IDs)–discharges with age, gender, diagnoses, valid ID, hospital, clinical number, county of residence, etc. Information at the individual level is necessary for diagnoses-based risk adjustment.

1.4.1 The Valid ID Data Subset

The dataset with individual valid IDs has 567,320 discharges. It includes the following information:

- Health Service: There are 28 Geographical Health Services in the Chilean Public Sector, each with a group of hospitals.

- Hospital: There are approximately 300 public hospitals and the 100 are private, Army, and other types of hospitals.
- Hospital level: In Chile the hospitals are classified into four complexity levels.
- Number of discharges: Discharge correlative numbers by hospital.
- Number of Clinical Record by patient: by hospital.
- ID, Sex and Age
- Patient's insurance affiliation: FONASA, ISAPRE, Armed Forces, without insurance (i.e., none), other
- FONASA classification of the patient income group: A (without or lowest income); B; C or D (highest income)
- Patient's county of residence
- Date in
- Date out
- Days of stays
- Diagnoses (ICD-10): 4 and 3 digit codes
- Hospital's clinical service (specialized services, for example, neonatology, gynaecology)
- Condition of discharge: dead or alive
- Surgery: yes or no

The following variables were calculated:

- Cost of bed per day
- Cost of PAD
- Cost of surgery
- Total cost
- GES: yes or no

We enter this dataset into the DxCG Software. Table 43 shows some statistics that compare the complete discharges dataset with the Valid ID dataset.

Table 43: Comparison of complete dataset and valid ID dataset (Chilean discharges 2001)

	Total Dataset	Valid ID Dataset
Total Discharges (% of national discharges)	1,566,187 (100.00%)	567,320 (36.20%)
Total Hospitals (% of the Chilean Hospitals)	394 99.50%	291 73.50%
Discharges in Public Hospitals (% of total discharges)	1,156,777 (73.90%)	397,404 (70.10%)
Discharges by Insurance System		
FONASA Discharges (% of total discharges)	1,114,300 (71.10%)	381,762 (67.30%)
ISAPRE Discharges (% of total discharges)	245,553 (15.70%)	91,384 (16.10%)
Discharges by Gender		
Male Discharges (% of total discharges)	603,492 (38.50%)	211,965 (37.40%)
Female Discharges (% of total discharges)	962,695 (61.50%)	355,355 (62.60%)
Male into FONASA discharges (% of FONASA discharges)	412,268 (37.00%)	137,653 (36.10%)
Female into FONASA discharges (% of FONASA discharges)	702,032 (63.00%)	244,109 (63.90%)
Male into ISAPRE discharges (% of ISAPRE discharges)	92,009 (37.50%)	30,304 (33.20%)
Female into ISAPRE discharges (% of ISAPRE discharges)	153,544 (62.50%)	61,080 (66.80%)
Discharges and Age		
Mean age (Stand. Dev.)	35.8 (24.40)	37.0 (23.90)
Mean age FONASA discharges (Stand. Dev.)	35.4 (25.20)	35.2 (24.70)
Mean age ISAPRE discharges (Stand. Dev.)	32.8 (20.30)	35.9 (18.60)
Discharges in age group 0 – 1 year (% of all discharges)	140,133 (8.90%)	41,065 (7.20%)
Discharges in age group 25 – 34 years (% of all discharges)	268,674 (17.10%)	99,735 (17.60%)
Discharges in 65 and more years (% of all discharges)	258,204 (16.50%)	97,429 (17.20%)
Days of stay		

Table 43: Comparison of complete dataset and valid ID dataset (Chilean discharges 2001)

	Total Dataset	Valid ID Dataset
Mean days of stay	5.5	5.5
(Stand. Dev.)	(10.60)	(10.20)
FONASA Discharges	6.0	5.8
(Stand. Dev.)	(11.30)	(10.70)
ISAPRE Discharges	3.3	3.4
(Stand. Dev.)	(5.70)	(6.20)

Source: Author's calculations using hospitalisation data set

1.4.2 Cost comparison

After gathering the data with valid IDs, we compare its costs with those for the complete dataset. We use t tests to determine if average costs and costs variances were equivalent between the two groups, that is, of overall expenditures of both FONASA and ISAPREs beneficiaries.

Table 44: General comparison of mean costs (US dollars 2002)

Group	Case origin	N	Mean costs	Standard deviation
Total cost Males+	Total data set	461,712	468	831
	Valid ID Sample	149,811	484	819
Total cost Females*	Total data set	794,327	344	598
	Valid ID Sample	278,920	343	586
Total cost***	Total data set	1,256,039	389	695
	Valid ID Sample	428,731	393	680

*Non significant difference of means to 10%,
** Non significant difference of means to 5%;
*** Non significant difference of means to 1%;
+ Significant difference of means
Source: Author's calculations

Total mean costs are not different at a 1% level of significance, nor are costs for women different at a 10% level of significance. However, total average costs for men are significantly different.

Table 45 shows the average costs by age group. Here we can see that there are significant differences in the averages in the 0-4, 5-9 and 10-14 age groups. Nevertheless, the hypothesis that average costs for all other age groups are the same cannot be rejected at statistically significant levels.

Table 45: Comparison of mean costs by age groups

Age group	Dataset	N	Average costs	Standard deviation
00-04 +	Complete data set	171,989	399.36	877.83
	Valid ID sample	52,195	425.23	849.56
05-09 +	Complete data set	59,468	368.50	564.28
	Valid ID sample	19,415	388.14	600.49
10-14 +	Complete data set	50,464	407.05	602.55
	Valid ID sample	16,516	432.14	681.61
15-19 *	Complete data set	87,691	279.69	536.00
	Valid ID sample	29,598	281.24	559.33
20-24 ***	Complete data set	104,683	259.61	505.56
	Valid ID sample	37,164	250.68	430.07
25-29 ***	Complete data set	112,680	270.94	478.76
	Valid ID sample	41,284	264.12	430.68
30-34 *	Complete data set	106,813	297.62	514.70
	Valid ID sample	39,372	295.23	548.56
35-39 **	Complete data set	91,886	336.80	546.71
	Valid ID sample	32,965	330.51	527.20
40-44 ***	Complete data set	67,172	406.96	729.85
	Valid ID sample	23,449	395.52	561.81
45-49 *	Complete data set	54,490	450.15	733.95
	Valid ID sample	18,506	451.13	735.51
50-54 *	Complete data set	51,739	483.13	804.05
	Valid ID sample	17,777	480.37	739.39
55-59 **	Complete data set	48,838	509.74	805.97
	Valid ID sample	17,058	523.25	835.84
60-64 *	Complete data set	49,067	522.76	867.91
	Valid ID sample	17,106	528.20	819.86
65-69 *	Complete data set	49,589	540.75	858.71
	Valid ID sample	17,565	549.25	884.39
70-74 *	Complete data set	53,002	537.57	767.61
	Valid ID sample	18,745	546.99	770.13
75-79 ***	Complete data set	41,054	530.44	775.06
	Valid ID sample	14,277	556.76	847.49
80 + ***	Complete data set	55,414	513.79	767.23
	Valid ID sample	15,739	538.29	818.34

*Non significant difference of means to 10%,
** Non significant difference of means to 5%;
*** Non significant difference of means to 1%;
+ Significant difference of means
Source: Author's calculations

Table 46 shows results for men by age group. The null hypothesis that the mean costs are the same across datasets cannot be rejected. This gives support to the premise that average costs are the same (except in the age group 0-4 years), although at different levels of statistical significance. Many of these tests comprising 10 groups reject the hypothesis of equal averages at 10%; two reject at 5%; and four at 1% significance.

Table 46: Comparison of mean costs by age group – Males

Age group	Dataset	N	Average costs	Standard deviation
00-04 +	Complete data set	98,637	395.32	872.24
	Valid ID sample	30,595	420.80	847.75
05-09 ***	Complete data set	35,259	365.40	553.90
	Valid ID sample	11,694	377.97	568.91
10-14 **	Complete data set	28,265	417.26	607.97
	Valid ID sample	9,296	432.59	687.33
15-19 ***	Complete data set	19,098	434.48	829.75
	Valid ID sample	5,923	464.06	930.62
20-24 **	Complete data set	17,491	454.02	944.09
	Valid ID sample	5,666	462.09	776.91
25-29 *	Complete data set	18,410	458.19	938.75
	Valid ID sample	5,837	479.54	833.44
30-34 ***	Complete data set	20,314	459.21	842.47
	Valid ID sample	6,744	497.47	1,021.84
35-39 *	Complete data set	21,798	465.24	825.17
	Valid ID sample	6,986	475.27	782.53
40-44 *	Complete data set	21,544	491.47	919.22
	Valid ID sample	7,012	484.14	700.85
45-49 *	Complete data set	20,035	505.64	881.89
	Valid ID sample	6,586	509.22	870.65
50-54 *	Complete data set	21,409	535.51	882.71
	Valid ID sample	7,374	531.84	761.87
55-59 *	Complete data set	22,643	554.97	858.23
	Valid ID sample	7,878	567.74	873.14
60-64 *	Complete data set	23,612	557.81	956.24
	Valid ID sample	8,233	559.65	882.77
65-69 *	Complete data set	24,911	567.91	876.55
	Valid ID sample	8,747	575.43	894.91
70-74 *	Complete data set	26,253	553.33	772.82
	Valid ID sample	9,098	561.68	787.23
75-79 *	Complete data set	19,376	536.24	782.01
	Valid ID sample	6,559	554.94	862.42
80 + ***	Complete data set	22,657	488.52	704.64
	Valid ID sample	5,583	514.41	761.95

* No significant difference of means to 10%,
** No significant difference of means to 5%;
*** No significant difference of means to 1%;
+ Significant difference of means
Source: Author’s calculations

In most age groups for women we cannot reject the null hypothesis that their mean costs are equal at a significant statistical level. In fact, we cannot reject the null at a 10% level for seven of them, at the 5% level for three and three at 1%. However, there are four groups, whose average costs are not the same, including the three groups between 0 and 14 years of age and the 20 and 24 years of age group. Table 44 shows that total cost for men was significantly different, but not for women.

Table 47: Comparison of mean costs by age group – Females

Age group	Dataset	N	Average costs	Standard deviation
00-04 +	Complete data set	73,352	404.78	885.28
	Valid ID sample	21,600	431.50	852.10
05-09 +	Complete data set	24,209	373.03	579.04
	Valid ID sample	7,721	403.54	645.11
10-14 +	Complete data set	22,199	394.06	595.34
	Valid ID sample	7,220	431.57	674.22
15-19 *	Complete data set	68,593	236.59	408.74
	Valid ID sample	23,675	235.50	405.01
20-24 +	Complete data set	87,192	220.61	344.93
	Valid ID sample	31,498	212.65	316.52
25-29 ***	Complete data set	94,270	234.37	306.10
	Valid ID sample	35,447	228.64	304.57
30-34 ***	Complete data set	86,499	259.67	391.00
	Valid ID sample	32,628	253.43	370.31
35-39 **	Complete data set	70,088	296.86	416.36
	Valid ID sample	25,979	291.59	425.30
40-44 **	Complete data set	45,628	367.06	616.67
	Valid ID sample	16,437	357.71	485.77
45-49 *	Complete data set	34,455	417.88	629.97
	Valid ID sample	11,920	419.03	646.69
50-54 *	Complete data set	30,330	446.15	741.33
	Valid ID sample	10,403	443.89	720.84
55-59 *	Complete data set	26,195	470.65	755.74
	Valid ID sample	9,180	485.06	800.53
60-64 *	Complete data set	25,455	490.25	775.65
	Valid ID sample	8,873	499.01	755.70
65-69 *	Complete data set	24,678	513.33	839.44
	Valid ID sample	8,818	523.28	873.11
70-74 *	Complete data set	26,749	522.11	762.16
	Valid ID sample	9,647	533.13	79.63
75-79 ***	Complete data set	21,678	525.26	768.78
	Valid ID sample	7,718	558.30	834.65
80 + **	Complete data set	32,757	531.27	807.24
	Valid ID sample	10,156	551.42	847.50

*No significant difference of means to 10%,
** No significant difference of means to 5%;
*** No significant difference of means to 1%;
+ Significant difference of means
Source: Author’s calculations

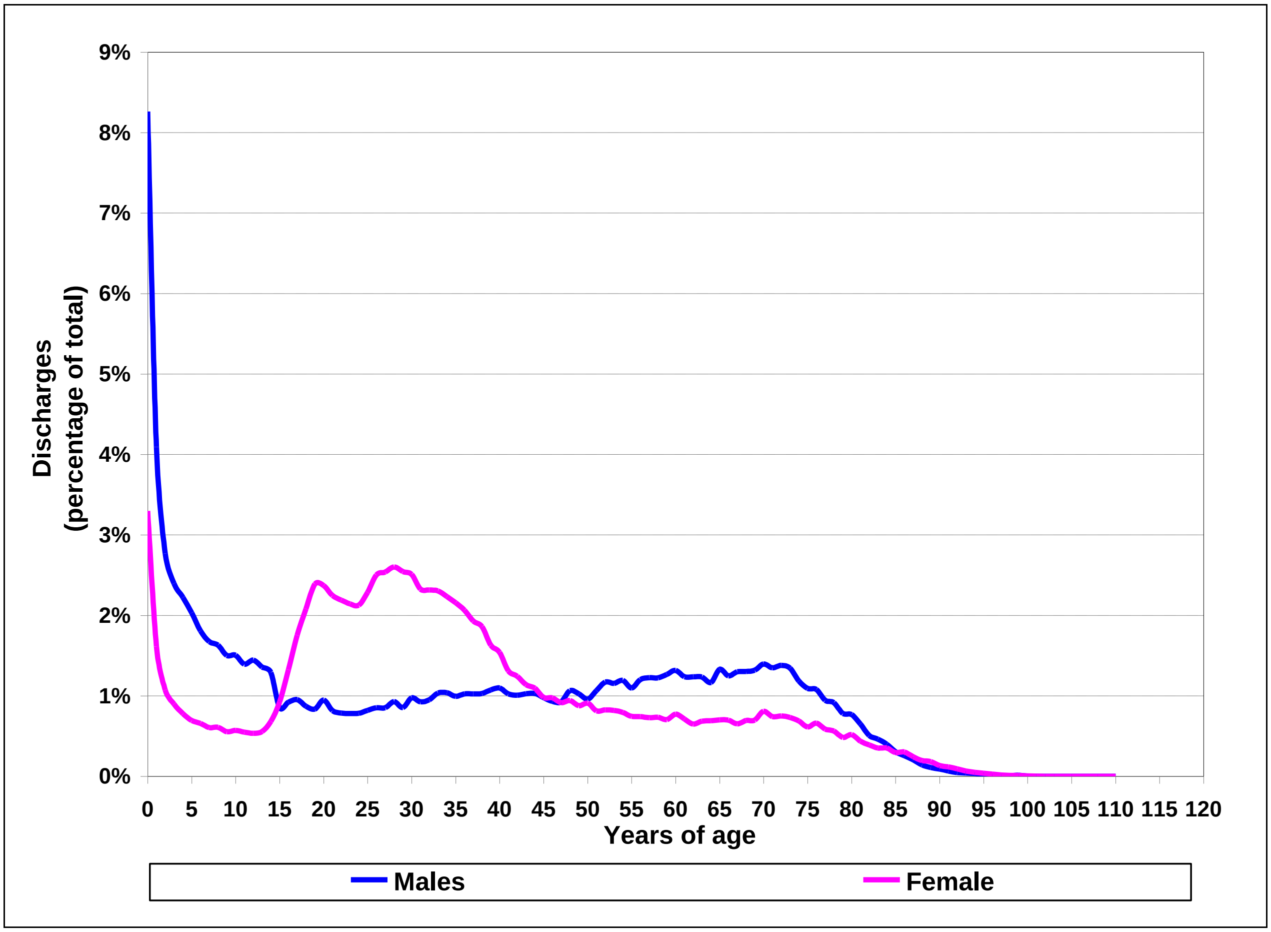
In sum, what these tests indicate is that we have a reasonably representative dataset of the total universe, with overall average costs which are significantly similar. We use the Valid ID dataset to apply diagnosis risk adjustment, but we remain aware that there are some problems regarding the representativeness in the three age groups from 0 to 14 years of age, particularly for women, although women's overall mean is more reliable. Also, tests for men's age groups are better but not strong enough to show that men's overall mean costs are the same across datasets.

1.4.2.1 Some data examination

We present some descriptive statistics of the valid ID dataset. The following figures provide a general overview of the results using the methodologies presented above.

Figure 16 show discharges by age and sex groups. It shows that there is a high use among newborns, in particular, men, and high use among women of fertile age. Men over 45 years of age show higher usage than women in this age range.

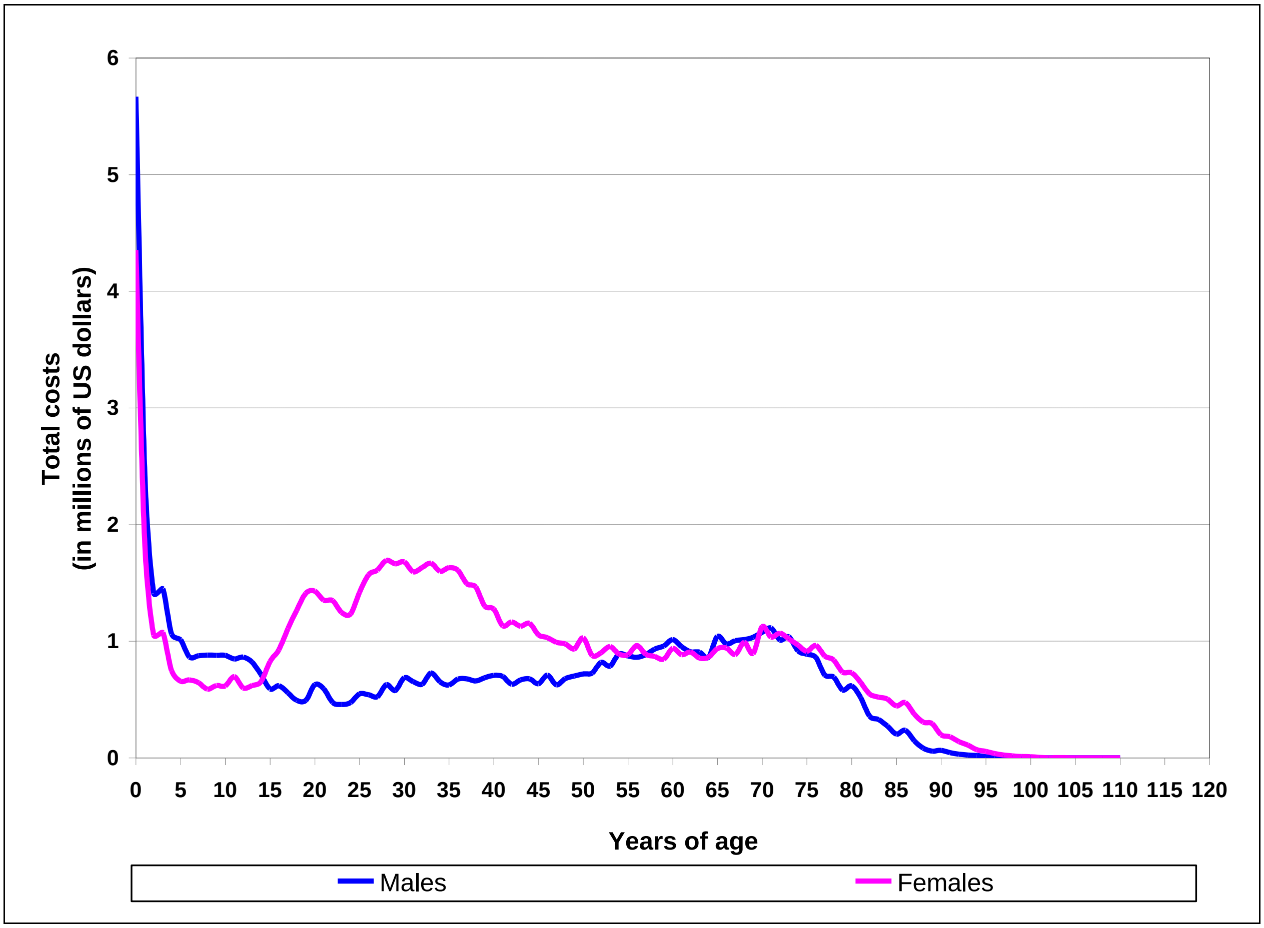
Figure 16: Hospital discharges by age and gender (%)



Source: Author analysis

We can make the same observations if we consider total costs (Figure 17) instead of utilization. The only exception is that although women over 45 use less hospital care than men, their total costs are either similar or higher than those for men.

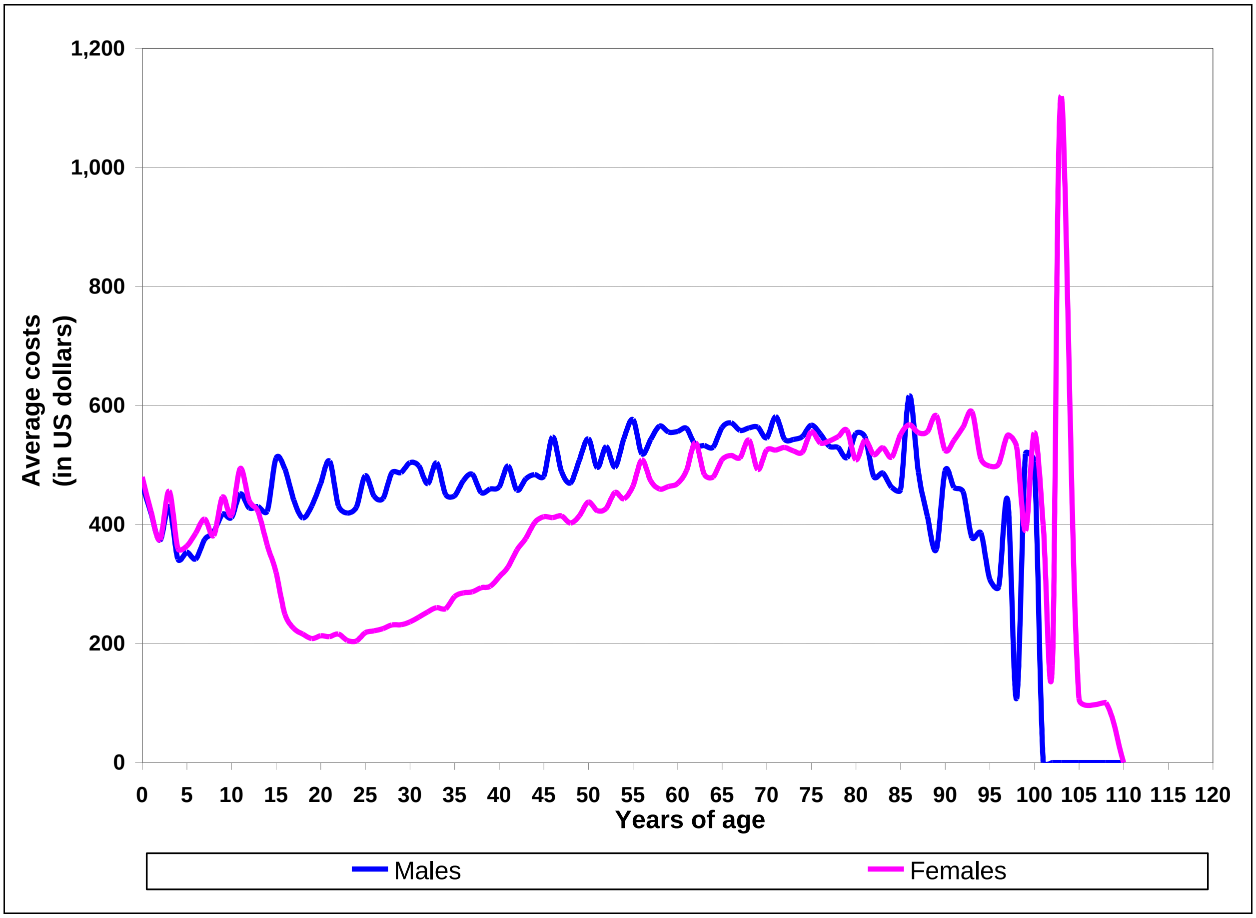
Figure 17: Total costs by age and gender



Source: Author analysis

Figure 18 refers to the average cost of hospital discharges by age and gender. Because women represent more cases, when we divide by the number of cases, the relation is inverted slightly for women of fertile age, relative to the previous figure.

Figure 18: Mean costs by age and gender



Source: Author's analysis.

2. Risk adjustment methods and morbidity

There are different models that use health status in risk adjustment. The most widely known classification systems are the Ambulatory Care Group (ACG) developed at Johns Hopkins University by Wiener and others (Weiner et al., 1991; Weiner et al., 2000) and the Diagnostic Cost Group (DCG) family of models developed at Boston University and Health Economics Research by Ash, Ellis and Pope (Ellis et al., 1996; Pope et al., 1998).

Table 48 shows that there are different risk adjustment models, which may differ due to:

- original goal, i.e., models that are meant to answer a specific question;
- adjustment variables, which may not be costs, i.e., hospitalisation stay or mortality, etc.
- type of patients and their morbidity

Table 48: Selected risk adjustment models

Acronym	Name and Source of Risk Adjuster	Risk of What?	Pertinent Populations	Role of Diagnosis
ACGs	Ambulatory Care Groups; The Johns Hopkins University	Resources consumption over the course of time based morbidity profile; risk of high cost; disease makers	All persons within a general population	Diagnoses from all patient encounters (inpatient and outpatient) used to assign persons to 1 of 32 ADGs
APACHE	Acute Physiology and Chronic Health. Cerner Corp., Kansas City.	There are several risks, for example: In-hospital mortality or In-hospital mortality and Multiple risk equations (hospital and ICU mortality and LOS, risk of active treatment, days on mechanical ventilation).	Adult in ICUs	Calculates APACHE score independent of diagnosis, using several categories
APR-DRGs	All Patient Refined Diagnosis Related Groups. 3M Health Information Systems.	There are 2 versions: resources use and in-hospital mortality	All hospitalised patients	Subclasses within DRGs based largely on secondary diagnoses
CDPS	Chronic Illness and Disability Payment System. University of California San Diego.	Total expenditures over the next year (prospective model) or present year (concurrent model)	Medicaid recipients; another version for Medicare beneficiaries	Assignments based on patterns of outpatient and inpatient diagnoses
MedicaidRx	Prescription drug-based model	Total expenditures over the next year for typical benefit package of an acute care HMO	Medicaid recipients	Diagnoses are proxied by prescription drugs
CSI	Comprehensive Severity Index. International Severity Information Systems, Salt Lake City.	Physiologic complexity comprising the extent and interactions of patients´ diseases presented to medical personnel	Separate components for: adult inpatients; pediatric inpatients; adult outpatients; pediatric outpatients, long-term care; hospice care and rehabilitation care	Each diagnosis generates specific criteria used to calculate diagnosis-specific severity for each disease present; overall scores consider severity of all diagnoses

Table 48: Selected risk adjustment models

Acronym	Name and Source of Risk Adjuster	Risk of What?	Pertinent Populations	Role of Diagnosis
DCG/HCC RxGroups PIP-DCGs	Diagnostic Cost Groups/Hierarchical Condition Category; DxCG, Inc., Boston Prescription drug-based model Principal Inpatient Diagnostic Cost Groups; DxCG and CMS	Total expenditures over the next year (prospective model) or present year (concurrent model); several options, including truncation costs and excluding pharmacy costs. Total expenditures (medical and pharmacy) over the next year (prospective model) or nonpharamacy expenditures this year (concurrent model) Total Medicare expenditures over the next year	All persons within a general population (including versions for Medicare, Medicaid and commercially insured) All persons in a general commercial (privately insured age < 65) population Medicare managed care enrolees	Assignment based on patterns of outpatient and inpatient diagnoses Inpatient diagnoses using DCG/HCC classification in one version For most persons, uses principal diagnosis only from acute care hospitalisations
DRGs	Diagnosis Related Groups; CMS and 3M Health Information Systems, Willingford, CT	Total charges or LOS	All hospitalised patients	Groups medical cases by diagnosis
DS Clinical Coded Staging Scale	Disease Staging; The MEDSTAT Group, Ann Arbor, MI; part of Thomson Corp.	Clinical version and Coded Staging version: complexity, etiology, and extent of organ system involvement Scale version: definition depends on individual scale: total charges/costs, LOS, and in-hospital mortality	All patients with one or more of 600+diseases covering all clinical conditions (Clinical) All patients (Coded Staging) All hospitalised patients (Scale)	Clinical criteria within diagnosis categories Diagnosis specific
MedisGroups	Atlas 3.7; Cardinal Health-Clinical Information Management; Marlborough, MA	Admission-based mortality risk, midstay mortality risk, admission-based LOS, LOS outlier status, others	All hospitalised patients	Diagnosis specific
NSQIP	National Surgical Quality Improvement Program; Department of Veterans Affairs, Washington, DC	Death within 30 days of major surgery; postoperative complications within 30 days of major surgery	Veterans undergoing major surgery in eight surgical specialities	Diagnoses important as comorbid conditions
PRISM	Pediatric Risk of Mortality Score	PICU mortality	Patients in PICUs	Includes diagnosis in calculating mortality risk

Source: Iezzoni, 2003. Chapter 2: Getting Started and Defining Terms in "Risk Adjustment for Measuring Health Care Outcomes"

The starting point of a diagnoses-based risk adjustment model is the idea that certain diagnoses are good predictors of health expenditure. The general recommendation is to adapt and try different models that have already been used elsewhere, especially the ones that incorporate multi-morbidity as predictors. For us, the Diagnostic Cost Groups (DxCG) family of models are the more interesting models, because they were applied before and they use inpatient data (Medicare-USA, Germany). Furthermore, these models have been previously applied in contexts similar to the one in Chile. These DxCG models have been further developed in Europe (van Vliet and van de Ven, 1993; Lamers and van Vliet, 1996; IGES, Lauterbach, Wasem et al., 2004; and Behrend et al., 2004, for Germany).

We believe that it is clear that the best approaches, and generally the more applicable ones, are those that use morbidity to predict expected costs.

There are three key assessments with these type of models: the first in 2002, sponsored by the US Society of Actuaries (Cumming and Cameron, 2002), the second in a 2004 study by IGES/Lauterbach/Wasem to assess 6 models with a representative dataset of 2 million insured in all sickness funds in Germany, and the third for the Netherlands by Rotterdam University (Lammers et al., 2003). These studies used models based on morbidity from the DxCG family. We chose the model for our research based on those studies, and used the simplest one to apply to the Chilean case. In sum, we selected a concurrent demographic model incorporating a simple binary indicator for hospitalisation and a concurrent DxCG/HCC model.

2.1. Advantages and disadvantages of inpatient information

For the Chilean health care system, we only have inpatient information at the individual level.

Paying adjusted per capita premiums based only on 1.6 million hospitalisations are representative of the 1 million individuals involved in these hospitalisations with diagnoses, but not of the remaining 12 million beneficiaries that do not have diagnoses (Wasem, 2001). Besides it is necessary to work on a representative subset of this dataset provided that only 36% of it contains valid ID of individuals. Other possible problems with the dataset are: limited information extension; costs have been imputed using external methods based on normative studies; and possible codification mistakes due to lack of knowledge and preparation of the responsible staff in Chile.

Inpatient admission for a short stay can represent significant expenditures for a health plan, particularly for a patient who may not really need this type of care. For example, the patient could have easily been scheduled for ambulatory level care (Pope et al., 2000). On the other hand, insurance companies may have an incentive to under-provide medical care, especially expensive services such as hospitalisation.

The advantages of inpatient-based risk adjustment are: inpatient diagnoses are obtained more easily and inexpensively; inpatient diagnoses are likely to be more accurate and are easier to audit and to verify by the sponsor; and there is also a proxy for severity of illness. It seems reasonable to begin the transition to risk adjustment payments by focusing on the most severely ill and expensive enrolees, who are most likely to be hospitalised (Pope et al., 2000).

2.2. The PIPDCG model for Medicare and DxCG/HCC Models

The Principal Inpatient Diagnostic Cost Group for Medicare risk adjustment (PIPDCG model) was developed by Ash et al., 1989; Ellis and Ash, 1995; Ellis et al., 1996; Pope, 1999; and after by Pope et al., 2000. It is a very interesting model for our purposes because the data set used for the model is similar to the Chilean data set and showed that diagnoses-based risk adjustment with inpatient data was possible.

The PIPDCG model was developed with data of Medicare inpatient services to fairly compensate health plans for the expected costs associated with the disease burden of their enrolees, using a 5% sample from the years 1995 and 1996. This was a prospective model in that diagnoses from hospitalisations in the base year (1995) were used to predict 1996 Medicare expenditures.

First, the PIPDCG model classifies ICD, 9^{th} revision (ICD-9) codes to 172 PIPDCG groups. Seventy-five groups were excluded because they had minor diagnoses (transitory, non-specific). Deductibles and co-payments were excluded. Diagnoses for short hospital stays (less than 2 days in this case the elderly) were also excluded.

All the diagnoses included create incentives for relatively healthy people that are admitted for minor diagnoses to obtain higher payment, but the model captures these costs in other factors such as sex and gender.

Using 24 age/sex cells, Medicare status interacted with sex and age cells (for socio-economic level), working-age (not included in the regression) status and 16 PIPDCG diagnostic categories assigned from prior-year principal hospital diagnosis, they estimated the incremental effects of these variables in Medicare expenditure in a linear multiple regression model.

Risk factors were obtained dividing the regression coefficients by mean expenditures. These factors were added to the beneficiary demographic risk factor to determine the total relative risk factor. Finally, the capitated payment is the product of a county rate, determined by the beneficiary's residence, and the risk factor obtained.

They review the predictability and assess the prediction power and the stability of the risk adjustment model. The authors concluded that PIPDCG model is far more powerful than the demographic factors model used previously. It is more equitable and generates more accurate capitated payments.

Whereas early versions of the PIPDCG model and the other DCG models only used a single condition that predicted the highest subsequent costs, recently revised DCG models seek to capture the cumulative cost effect of multiple conditions. Multiple condition DCG models use the DCG/HCC classification system that identifies and describes the important subset of costly patients with complex problems.

This model uses the full range of diagnoses and the multiple-condition generated during all "face to face encounters with clinicians" (Ash et al., 2000) and compares the ability of DCG/HCC models to predict resources in three different samples: privately insured, Medicaid and Medicare.

This classification system groups diagnoses into clinically homogeneous groups and it can identify groups of patients with higher and lower expected resource use. It uses the ICD-9 Clinical Modification (ICD-9-CM) or ICD-10 diagnosis codes from hospital claims.

This classification system was designed to be used at both the group and individual levels. It can identify the clinical conditions that drive observed relative risk scores. DCG models form groups of persons based on diagnoses present in a given year that are similar to expected annual costs. Comorbidity diagnoses form the basis of severity differentiation within the models.

Inpatient DCG models predict the costs using only ICD codes from inpatient admissions. Every valid ICD diagnosis is used to classify individuals and depending on the specific model being used, not all conditions are used to predict resource use.

Generally, each ICD code maps to one, and only one, DxGroup. For a few diagnoses, when treatment costs for pediatric and adult manifestations are substantially different, there are separate DxGroups for pediatric and adult members. Individuals with several diagnostic codes will generally map to several DxGroups.

The classification and demographic information is used to predict expenditures at the individual level using linear, additive formulas obtained from Ordinary Least Squares (OLS) regression to combine the expenses associated with diagnostic groupings (HCCs), age/sex cohorts and other demographic factors like type of insurance and other variables. Each diagnostic category, age/sex cohort and demographic category contributes to the cost weight in the final prediction.

This model has been studied and/or used for Medicare payments to HMOs, Medicaid payments and to predict total covered charges in commercial populations[53] in the USA, the Netherlands, Germany, England and Spain.

We use the DCG software to run a concurrent model with this study's sample. We describe the procedures in the next section.

[53] Commercial population refers to any beneficiary that is not in a social health program (for example, Medicare or Medicaid).

3. Diagnostic groups in DxCG/HCC models for Chile

The Diagnostic Cost Group Hierarchical Condition Category payment models (DxCG/HCC) summarize the health care problems and predict the health care costs of populations. These models use diagnoses generated by patients' encounters with medical care (in our case, inpatients encounters), using the patients' demographic and diagnostic profiles to predict costs. Here we describe the logical structure of these models.

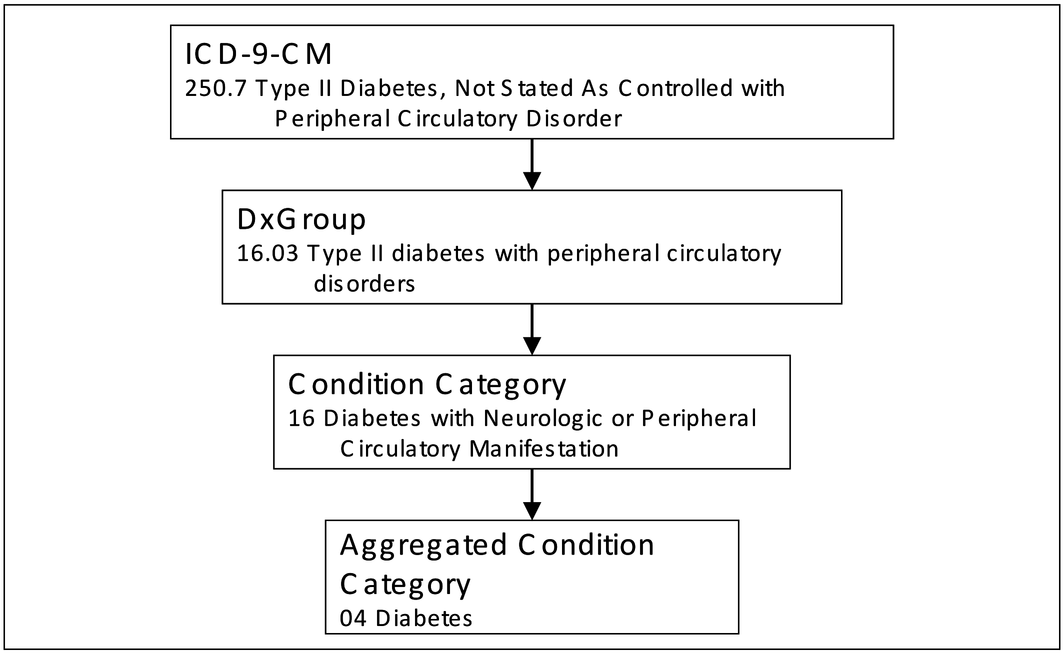
The original DCG models are prospective, that is, they use baseline information, or year 1, to infer the level of need for health care in year 2. Medical conditions detected in year 1 are used to organize people into groups with similar levels of future health care need.

There are later DCG models that were developed to estimate expected concurrent expenses, that is, expenses that occur in the same year as the diagnoses used to characterize the population. Both models can be used to determine a health-based payment, but concurrent models may be particularly useful for provider profiling and monitoring, because knowing all the medical problems being treated during a period of time is particularly relevant to estimate the level of resources used to treat them. However, prospective models that predict future costs are more appropriate to estimate payments to managed care organizations that assume financial risks. However, due to the data problems in Chile, we use retrospective or concurrent models only applied to the relevant population in Chile to explain and compare with a demographic model.

These models reflect a concern that payments should have appropriate incentives for health care plans, insurers and health care providers.

The DCG model was designed to use the more than 15,000 diagnostic codes from the ICD-9-CM. Currently the DCG model uses the new ICD-10. The Chilean data is in ICD-10 so we were able to use last version of the software (DxCG 6.1).

Figure 19: Example of DCG/HCC Classification

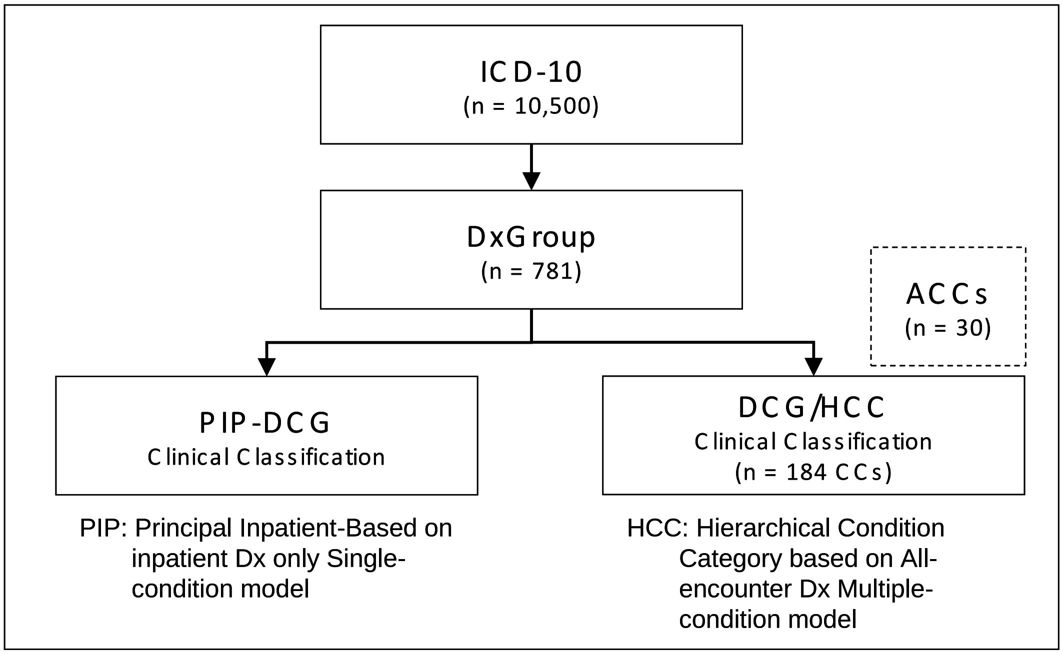


Source: DxCG Inc.

Each DCG/HCC model uses the same HCCs for prediction, all of which are based on diagnostic codes, rather than procedures. DCG summarizes a person's health from his or her HCCs and estimates expected costs based in these profiles. But not all HCCs are, or should be, used to compute payments, because there could be variations in coding practices like international coding proliferation, inconsistent coding of less serious or vague conditions, and other reasons including a policy decision.

The model groups ICD codes into 781 categories called "DxGroups" which are the building blocks of DCG/HCC models. Hence, each ICD code maps to a unique DxGroup, and each DxGroup encompasses diagnostic codes that describe very similar medical problems.

Figure 20: DCG/HCC classification and ICD code



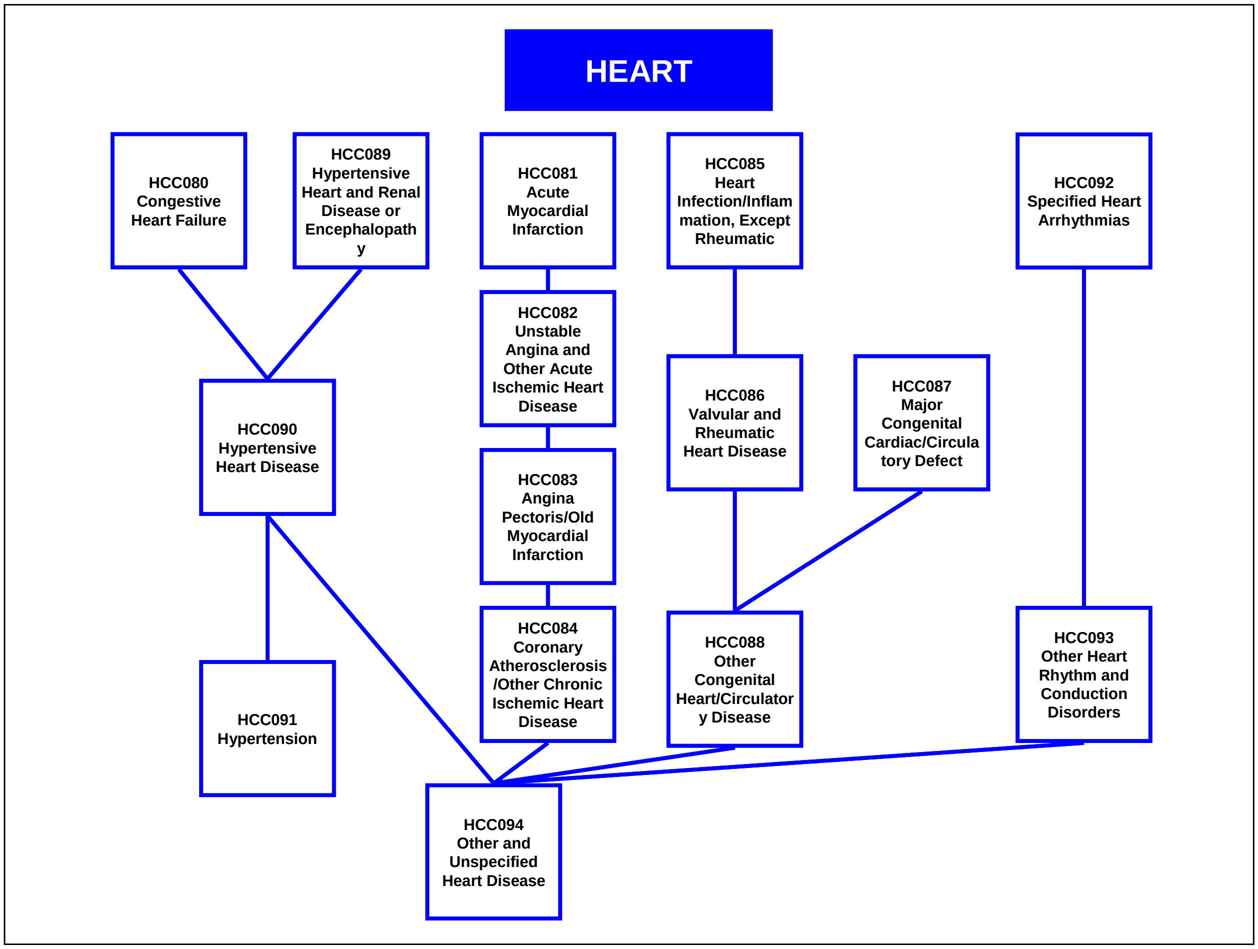
Source: DxCG Inc.

The model addresses the problem of multiple diagnoses per beneficiary by introducing a hierarchy (184 HCCs) that identifies only the single most predictive diagnosis of higher future expenditures and ignores all other diagnoses, using the DCG sorting algorithm. HCCs are groups of DxGroups that are clinically related and imply similar resource use. The DCG algorithm represents a person's health status with his or her HCCs, and the econometric model uses these HCCs to estimate expected costs.

The DCG/HCC models incorporate disease hierarchy structures. Disease Hierarchies are made up of two or more hierarchical condition categories, or HCCs, the collection of 184 clinical elements that make up the granular units used when applying model weights. A Simple Hierarchy is straight-line arrangement where each HCC supersedes the HCC below it in the hierarchy; in other words, elements of a Simple Hierarchy closer to the top are associated with increasing severity of the clinical disease process. Complex Hierarchies are a collection of single HCCs and/or Simple Hierarchies that more completely describe a disease or a subunit of a disease. Relations between

HCCs in a Complex Hierarchy may be subordinate or peer. Figure 21 presents the heart disorder hierarchy as an example of Complex Hierarchies.

Figure 21: Example: Heart disorder hierarchy



Source: Analytic Guide Release 6.1. DxCG Risk Adjustment Software

In this example a broad range of HCCs in the Heart Disorder hierarchy (numbers 80,81,85,89,92) disqualify a person from being classified into less clinically serious and less specific HCCs, such as numbers 82-84, 86-88, 90, 91, 93 and 94.

The model selects diagnoses for inclusion because including all diagnoses in the risk adjustment model create incentives for even relatively healthy people to be admitted for minor diagnoses to obtain higher payments. The model excludes diagnoses that may be minor, transitory or non specific and other events with diagnosis are excluded by the sorting algorithm. Because the model is fully hierarchical and assigns beneficiaries to a single diagnostic category within a given hierarchy, readmission for the same lower future cost diagnoses does not affect the model's resource allocation results. Although incentives for hospitalisation are inherent in any inpatient-based risk adjustment model, the model does not reward multiple hospitalisations within the same hierarchy.

The central feature of the model is that it computes each beneficiary's relative risk factor. A beneficiary whose expenditures are predicted to equal national average has a relative risk factor of 1.00. Risk factors greater than 1.00 indicate above-average expected costliness, and factors below 1.00 indicate lower-than-average expected costs.

First, the model computes a demographic factor, then it selects the corresponding DCG risk factor and finally it sums the demographic and DCG factors to obtain a relative risk score.

3.1. Method of estimation for DxCG model in Chile

Table 49 shows the parameters and options selected in the DxCG Inc. software to process the data for the regression analysis.

Table 49: Software parameters and options used

DxCG, Inc.	
REPORT PARAMETERS AND USER OPTIONS	
SYSTEM PARAMETERS:	
DxCG Release:	6.1.1
Operating environment:	Stand-alone Version, WIN32
DxCG software serial number:	50204
Maximum licensed population size:	750,000
INPUT FILES:	
Main DxCG person-level file:	testdata1\dxcgout9.txt
DxCG summary file:	Not output by Stand-alone version
Population group:	Commercial
Model variant:	Inpatient, DCG/HCC
Model purpose:	Explanation
Model outcome:	Medical Expenses Excluding Pharmacy Spending
Level of clinical detail available:	ACCs, CCs and DxGroups
Hierarchies imposed:	No
Over age 64 included:	Yes
Number of people in main DxCG file:	185,825
OPTIONS:	
Model year:	Concurrent
Year description:	Calendar 2001
Weighting:	Weighted by Eligible Months
Expenditure average for Year 1:	212
Expenditure average for Year 2:	Not used
Abbreviation of model dimensions:	Inpatient/Concurrent/Comm/Expl/MedOnly
Group variable used:	Not used by Stand-alone version
Format used with group variable:	Not used by Stand-alone version
Group variable name:	Age, sex, insurer

Source: DxCG 6.1 software.

Given the dataset for Chile, we can use a concurrent (or retrospective) model. A concurrent application involves using claims data from a period of time, to predict medical claims costs for that same period. The risk weight reflects an estimate of the marginal cost for a given medical condition relative to the base cost for individuals with no medical conditions.

To run a concurrent model, we take the following steps:

1) Assign the medical condition categories in the valid ID data set (hospital discharges in 2001). This is done using the DxCG software which selects HCC/DCG conditions;

2) Include in the matrix of the output file from the DxCG software the FONASA and ISAPRE beneficiaries who were not hospitalised and those hospitalised who did no have valid ID in 2001;

3) Run a linear regression to recalibrate risk weights (coefficients with Chilean data);

    a) The data was randomly split into two disjointed datasets of approximately equal size: one is the calibration subset and the other the validation subset.

    b) We use the calibration subset to recalibrate risk weights. Then we used the validation subset to estimate the measure of predictive accuracy. From one calibration model the recalibrated risk weights were obtained and measures of predictive accuracy were derived by computing recalibrated risk weights to assign expenditures for each member in the validation data set.

4) Analyse the predictive accuracy of the model by comparing the score of each member or member groups to the actual expenditure.

    a) We use the validation subset to compare the predicted expenditures of each member or groups of members to the actual expenditures (see Cumming and Cameron, 2004).

We use OLS regression results[54] to combine the expenses associated with diagnostic groupings (HCCs) by age/ sex cohorts.

$$exp_i = \beta_0 + \sum_{j}^{17} \beta_j \left(s \cdot a_j\right) + \sum_{k}^{184} \gamma_k HCC_k + \mu_i \tag{13}$$

[54] We use SPSS V.13 and Clementine V.9 software to run the OLS regressions. The program automatically selects which dummies to exclude from the analysis.

$$
\begin{aligned}
&where:\\
&exp_i: expenditure\ individual\ i\\
&s: sex\\
&a_j: 5\text{-}year\ age\ groups\ (j=1: 0\text{-}4; \ldots; j=16: 75\text{-}79;\ and\ \ j=17: 80\ and\ older)\\
&HCC_k: Hierarchical\ Condition\ Category\ k\\
&\mu_i: error\ i
\end{aligned}
$$

The number of age/gender group entries was recalibrated from DxCG software. For all three models, there were 34 age/gender groupings, 17 for females and 17 for males. The groupings for both sexes are as follows: 0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79 and 80 and older.

3.2. Measures of predictive performance

We measure predictive performance at the individual level using individual adjusted R-squared (adjusted-R^2) and the mean absolute prediction error (MAPE). We assess predictive performance at the group level using predictive ratios (PR) of expenditure quintiles.

Individual adjusted-R^2 is used to estimate model fit and describes the percentage of the individual variance in actual expenditures that is explained by the model. The formula for adjusted-R^2 is:

$$R^2 = 1 - \left(\sum_i (a_i - \hat{a}_i)^2\right) \div \left(\sum_i (a_i - \bar{a})^2\right) \tag{14}$$

$$
\begin{aligned}
&where:\\
&a_i: \text{Actual expenditure for person } i\\
&\hat{a}_i: \text{Predicted expenditure for person } i\\
&\bar{a}: \text{Mean of actual expenditures}\\
&i = 1,\ldots,n \text{ and } n \text{ is the number of people in the sample}
\end{aligned}
$$

MAPE is defined as the mean of the absolute difference between actual and predicted expenditures across all individuals and is calculated as follow:

$$MAPE = \frac{\sum_i |a_i - \hat{a}_i|}{n} \tag{15}$$

$where:$

a_i : Actual expenditure for person i

$\hat{a}_i$: Predicted expenditure for person i (from regression model)

$i = 1,...,n$ and n is the number of people in the sample

Predictive ratio (PR) of expenditure quintile is a group measure and can be calculated as the ratio or the aggregated predicted expenditure for a given group of beneficiaries, over the aggregated actual expenditure for the same group of people. The formula is:

$$PR_g = \frac{\sum_{ig} \hat{a}_{ig}}{\sum_i a_{ig}} \tag{16}$$

$where:$

PR_g : Predictive ratio for group g

a_{ig} : Actual expenditure for person i in group g

$\hat{a}_{ig}$: Predicted expenditure for person i in group g

VI. RESULTS AND ANALYSIS OF PREDICTIVE ACCURACY OF THE DIAGNOSES-BASED MODEL FOR CHILE

In this chapter we analyse the regression model described at the end of the previous chapter with the data described in chapter IV. We present the results of the concurrent simulation of a risk adjustment model.

1. Descriptive statistics

The population composition was about 50.5% female, with a mean age of 33 years and a standard deviation of 21 years. Approximately 8.5% of those insured were age 65 and older. All of those insured had at least 12 months of health insurance coverage (Table 50).[55]

[55] This was assumed because of problems identifying the variables. Each individual remains in the first observed insurance scheme he or she appeared in during the year, and in which he/she remained throughout the rest of the year as a beneficiary.

Table 50: Demographics and inpatient expenditure

	Concurrent Application
N	13,098,480
Year	2001
% female	50.5%
Age	
Mean	33
SD	21
% age under 20	35.6%
% age 20 - 44	38.8%
% age 45 - 64	17.2%
% age over 64	8.50%
Year Expenditure (US dollars Dec 2002)	
Mean	8.89
Standard deviation	156.51
Coefficient of variation	17.61
% with non-zero expenditure	1.42%

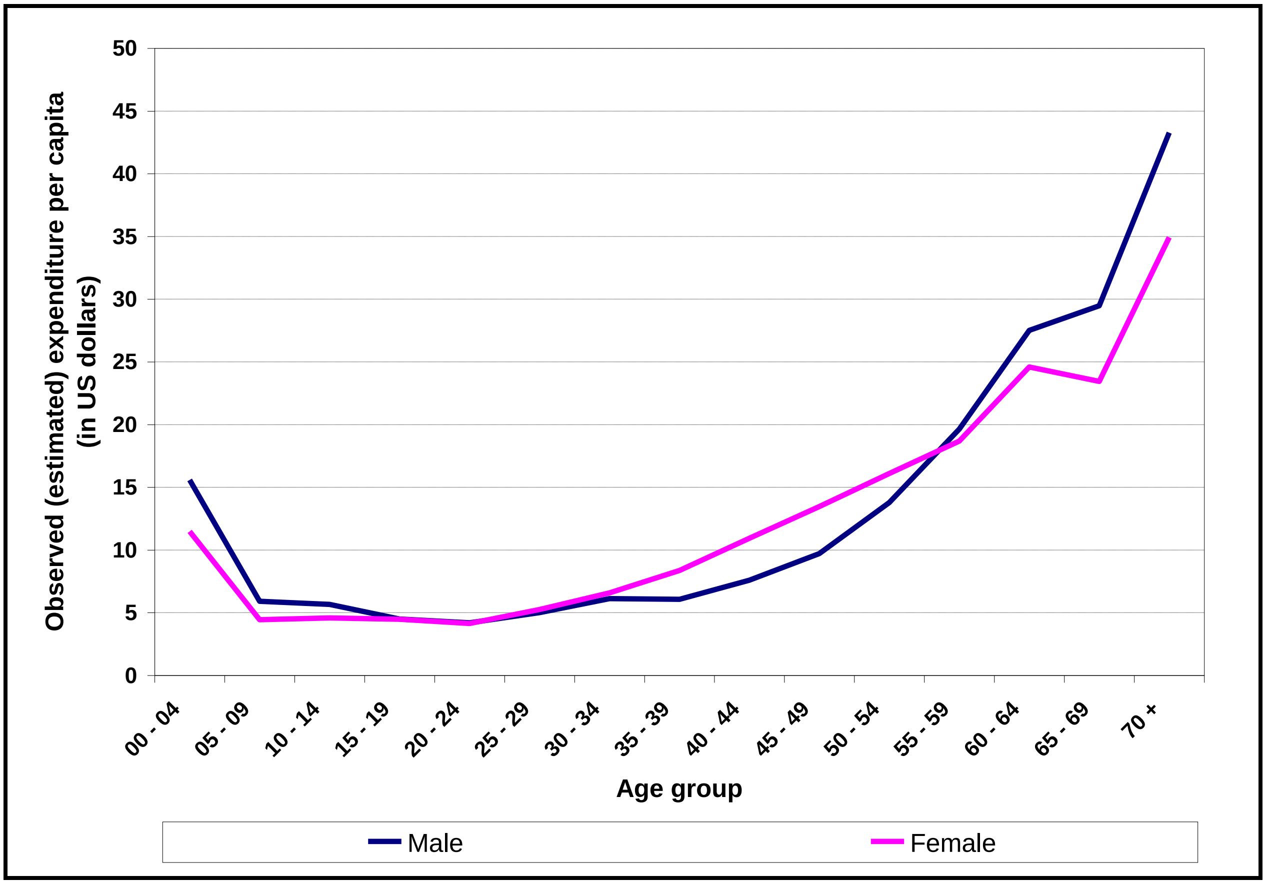
Source: Elaborated by the author.

Annual inpatient health care expenditure in this sample is US$ 8.89 per capita and US$ 626.65 per inpatient, with coefficient of variation roughly 17.6 times larger than the mean. Only 1.42% of the population has hospitalisation costs and had valid IDs, from a total hospital expenditure of US$ 74.39 million, which represents 35% of the estimated total hospitalisation costs.

A total of 185,824 patient/diagnosis pairs for 13 million beneficiaries in 2001 were submitted to the grouping software, with a unique principal diagnosis code per hospitalised individual.

The per capita estimated observed costs by sex and age groups for these 185,824 patients are shown in Figure 22.

Figure 22: Per-capita observed (estimated) expenditure of the sample for DxCG Risk adjustment model



Source: Author

About 16% of the hospitalised beneficiaries are age 65 and older and 23.4% are age 60 and older. About 25% of the hospitalised beneficiaries are children and 46% are males (Table 51).

Table 51: Inpatients: children, males and the elderly, 2001

Group	Number	%
Children (under 15 years of age)	46,836	25.2%
Males	85,353	45.9%
Elderly (60 years of age and above)	43,498	23.4%

Source: Author's analysis.

2. Analysis by diagnosis

A key output of the DxCG software is the diagnosis categories or groupings for the data provided. We analyse these results in this section.

First we consider the cases dropped. Approximately 810 of every 10,000 cases submitted were incompatible with age or gender or were identified as numerically invalid. Another 15,063 or 8.1% of the hospitalisations were assigned “No HCC,” 397 or 0.2% of the hospitalisations were “Not valid” and 14,666 or 7.9% of the hospitalisations were “No Diagnoses”. All beneficiaries who were ever hospitalised are assigned to at least one HCC, if they had a valid diagnosis code.

Hospitalisations are primarily attributable to gastrointestinal conditions (Aggregated Condition Category (ACC) 07 with 40,324 patients, 19.4% of total cases), lung conditions (ACC19 with 28,045 patients, 13.5% of total cases), musculoskeletal and connective tissue (ACC08, 12,172, patients, 5.8% of total cases), benign/in situ/uncertain neoplasm (ACC03, 11,653 patients, 5.6% of total cases) and heart conditions (ACC16, with 11,113 patients, 5.3% of total cases).

The most frequent HCCs are “other gastrointestinal disorders” (HCC036) representing 10.2% of hospitalisations; “appendicitis” (HCC035) accounting for 5.2%; “other neoplasms” (HCC013, 4.9% of hospitalisations); “other musculoskeletal and connective tissue disorders” (HCC043, accounting for 3.6% of hospitalisations) and “gallbladder and biliary tract disorders” (HCC030) accounting for 3.2% of hospitalisations.

A number of HCC categories rarely occur in the dataset and 14 HCC categories have no observations in 2001; 8 of the 170 categories with observations have frequencies of less than 10 cases.

Table 52: Frequency of aggregated condition categories

Aggregated Condition Category (ACC)	Total	Percentage
All People	185,825	
01: Infectious and Parasitic	6,466	3.1%
02: Malignant Neoplasm	10,446	5.0%
03: Benign/In Situ/Uncertain Neoplasm	11,653	5.6%
04: Diabetes	4,434	2.1%
05: Nutritional and Metabolic	2,253	1.1%
06: Liver	9,608	4.6%
07: Gastrointestinal	40,324	19.4%
08: Musculoskeletal and Connective Tissue	12,172	5.8%
09: Hematological	1,830	0.9%
10: Cognitive Disorders	696	0.3%
11: Substance Abuse	1,624	0.8%
12: Mental	3,239	1.6%
13: Developmental Disability	238	0.1%
14: Neurological	3,975	1.9%
15: Cardio-Respiratory Arrest	1,096	0.5%
16: Heart	11,113	5.3%
17: Cerebro-Vascular	3,790	1.8%
18: Vascular	5,877	2.8%
19: Lung	28,045	13.5%
20: Eyes	7,533	3.6%
21: Ears, Nose and Throat	12,421	6.0%
22: Urinary System	4,033	1.9%
23: Genital System	1,730	0.8%
24: Pregnancy-Related	3,682	1.8%
25: Skin and Subcutaneous	5,731	2.8%
26: Injury, Poisoning, Complications	4,443	2.1%
27: Symptoms, Signs and Ill-Defined Conditions	3,287	1.6%
28: Neonates	2,232	1.1%
29: Transplants, Openings, Other V-Codes	213	0.1%
30: Screening / History	4,176	2.0%
Total	**208,360**	**100.0%**

Source: DxCG 5.1 Software using national discharges from the Chile data subset, 2001

3. Predictive performance

3.1. Individual level predictive performance

Table 53 summarises the predictive performance of the risk assessment models and the DCG/HCC model with recalibrated weights as measured by the R^2 and MAPE statistics, using this concurrent approach.

The demographic model that adjusts only by age and gender has the lowest predictive power. The demographic model that combines hospitalisation performs substantially better than the previous model, but not as well as the diagnoses model. In fact, there are substantial increases in predictive performance when we differentiate those who were hospitalised.

Table 53: Summary of individual level predictive performance

	Concurrent application	
N population insurances system	13,098,480	
N sample from HOSP (Expend>0)	185,824	
Mean Expenditure (US dollars Dec. 2002)	8.89	
Risk Adjustment Model	**R^2 adj [%]**	**MAPE [US dollars]**
Age*Gender	2.6	16.46
Age*Gender*HOSP	21.5	7.44
Age*Gender *DCG/HCCs (Reparameterised)	36.1	6.06

Source: Elaborated by the author

Based on adjusted-R^2, the demographic model explains only 2.6% of the variance in total actual expenditure. Incorporating a binary variable for hospitalisation increases the adjusted-R^2 value to 21.5%. However, with an adjusted-R^2 of over 36.1%, the predictive performance of the reparametrised DCG/HCC model shows a 68% improvement in comparison to the demographic model with hospitalisation and performs 14 times better relative to the demographic model.

We use the MAPE indicator to compare all three models. MAPE provides similar rankings of the models' predictive performance as the adjusted-R^2. Keeping in mind that we want the smallest MAPE possible from a model, the MAPE ranges from US$ 16.46 in the age and sex model to

US$ 7.44 when we include hospitalisation, and reaches US$ 6.06 when we include diagnoses to the demographic model. Comparing the last two models we have a 23% increase in costs generated by the diagnoses model relative to the demographic hospitalisation model. And when we compare with the demographic model to the diagnoses model, the latter is 2.7 times better.

3.2. Group level predictive performance

In this subsection we analyse the predictive performance of the models by expenditure quintiles. The relative rankings of the models remain unchanged when comparing their concurrent predictive performances for groups of beneficiaries with relatively high, medium and low expenditure.

Table 54: Summary of group level predictive accuracy for actual expenditure quintiles

Risk Adjustment Model	Concurrent application	
	Actual Mean [US dollars Dec. 2003]	PR
Quintile 1	60.26	
Age*Gender		64.40
Age*Gender*Hosp		10.39
Age*Gender*DCG/HCCs		7.01
Quintile 2	211.37	
Age*Gender		0.29
Age*Gender*Hosp		2.96
Age*Gender*DCG/HCCs		2.06
Quintile 3	362.42	
Age*Gender		0.17
Age*Gender*Hosp		1.73
Age*Gender*DCG/HCCs		1.39
Quintile 4	610.95	
Age*Gender		0.14
Age*Gender*Hosp		1.03
Age*Gender*DCG/HCCs		1.05
Quintile 5	1,907.14	
Age*Gender		0.04
Age*Gender*Hosp		0.33
Age*Gender*DCG/HCCs		0.54

Note: Mean expenditure is calculated using rows with actual expenditure >0 only.
Source: Elaborated by the author

The demographic model clearly is overpaying for the lower expenditure quintile and underpaying for the rest of the expenditure quintiles. The demographic model with the binary variable for hospitalisation and the diagnosis-based model are overpaying for the low expenditure quintile (10 and 7 times, respectively) and, underpaying for the high expenditure quintiles (0.33 and 0.54 respectively). In comparison, the DxCG/HCCs model performs better; though the DxCG/HCCs model still overpays the low-expenditure beneficiaries and underpays high-expenditure beneficiaries.

In conclusion, age/gender based models are easy to develop and use but inadequate because they consider only a few relevant patient characteristics. In fact, in our sample it explains only a small part of variation in individual resource use, with adjusted-R^2= 0.026, i.e., 2.6% of variation. When this model is used for payments, it favours selection and causes access problems.

The diagnoses-based model incorporates many differences in expected costs concurrently. It explains more of the observed variation in health spending across individuals. In our sample this model results in an adjusted-R^2 of 0.361, i.e., it explains 36.1% of variation.

Incorporating the binary variable for hospitalisation into the demographic model achieved an adjusted-R^2 of 21.5%.

3.3. Variables' statistical performance

Table 55 shows the coefficients and t tests of all the models' variables.

Table 55: Coefficients and statistical significance, Age*Gender*DCG/HCCs Model

	Non-standardised coefficients		Standardised coefficients		
Variable	**B**	**Standard error**	**Beta**	**t**	**Significance level**
(Constant)	-0.35	0.12		-2.91	0.03
SEX	-0.14	0.07	0.00	-1.99	0.05
HCC002	871.71	4.14	0.05	210.59	0.00
HCC003	1,236.13	4.81	0.06	256.80	0.00
HCC004	1,666.35	4.35	0.08	382.79	0.00
HCC005	1,327.30	20.27	0.01	65.49	0.00
HCC006	285.53	1.94	0.03	147.50	0.00
HCC007	2,539.18	3.77	0.15	673.65	0.00
HCC008	900.96	2.49	0.08	361.84	0.00
HCC009	1,437.51	3.36	0.10	428.07	0.00
HCC010	739.66	1.90	0.09	388.43	0.00
HCC011	426.45	5.67	0.02	75.16	0.00
HCC012	492.85	3.40	0.03	145.03	0.00
HCC013	415.11	1.20	0.08	345.25	0.00
HCC014	233.73	3.92	0.01	59.63	0.00
HCC015	477.24	11.14	0.01	42.85	0.00
HCC016	868.02	3.22	0.06	269.98	0.00
HCC017	1,047.57	4.24	0.05	247.27	0.00

	Non-standardised coefficients		Standardised coefficients		
Variable	B	Standard error	Beta	t	Significance level
HCC018	681.26	12.89	0.01	52.84	0.00
HCC019	344.12	2.70	0.03	127.66	0.00
HCC021	8,581.83	14.91	0.13	575.60	0.00
HCC022	469.22	6.59	0.02	71.16	0.00
HCC023	334.96	12.70	0.01	26.38	0.00
HCC024	322.77	2.93	0.02	110.02	0.00
HCC025	71.74	4.84	0.00	14.82	0.00
HCC026	228.31	3.94	0.01	57.92	0.00
HCC027	67.01	17.39	0.00	3.85	0.00
HCC028	1,016.41	7.00	0.03	145.23	0.00
HCC029	163.80	4.17	0.01	39.25	0.00
HCC030	537.26	1.47	0.08	365.37	0.00
HCC031	1,462.80	2.78	0.12	525.98	0.00
HCC032	912.65	9.63	0.02	94.78	0.00
HCC033	10.56	7.72	0.00	1.37	0.17
HCC034	854.24	1.80	0.11	474.97	0.00
HCC035	923.37	1.15	0.18	800.11	0.00
HCC036	442.84	0.83	0.12	535.52	0.00
HCC037	750.69	5.11	0.03	146.86	0.00
HCC038	579.69	4.86	0.03	119.20	0.00
HCC039	836.43	2.58	0.07	324.11	0.00
HCC041	440.42	4.32	0.02	101.88	0.00
HCC042	252.85	11.28	0.00	22.41	0.00
HCC043	297.72	1.38	0.05	215.44	0.00
HCC044	829.71	8.00	0.02	103.68	0.00
HCC045	1,294.58	15.95	0.02	81.14	0.00
HCC046	288.83	6.06	0.01	47.66	0.00
HCC047	322.84	3.61	0.02	89.35	0.00
HCC048	630.42	11.18	0.01	56.38	0.00
HCC049	759.93	6.45	0.03	117.91	0.00
HCC050	580.07	8.36	0.02	69.42	0.00
HCC051	250.08	5.60	0.01	44.63	0.00
HCC052	728.44	3.87	0.04	188.04	0.00
HCC053	225.27	9.40	0.01	23.96	0.00
HCC054	1,377.55	4.86	0.06	283.21	0.00
HCC055	735.52	5.36	0.03	137.13	0.00
HCC056	628.27	12.31	0.01	51.05	0.00
HCC057	556.89	7.70	0.02	72.31	0.00

	Non-standardised coefficients		Standardised coefficients		
Variable	B	Standard error	Beta	t	Significance level
HCC058	380.43	3.82	0.02	99.57	0.00
HCC059	317.78	7.72	0.01	41.17	0.00
HCC060	226.92	5.17	0.01	43.91	0.00
HCC061	903.61	41.04	0.00	22.02	0.00
HCC062	444.73	86.89	0.00	5.12	0.00
HCC063	473.79	16.30	0.01	29.07	0.00
HCC064	614.16	11.02	0.01	55.71	0.00
HCC065	508.21	17.76	0.01	28.61	0.00
HCC066	2,045.04	122.99	0.00	16.63	0.00
HCC067	1,440.89	15.92	0.02	90.54	0.00
HCC068	953.49	10.15	0.02	93.96	0.00
HCC069	492.55	8.72	0.01	56.47	0.00
HCC070	1,386.57	22.08	0.01	62.80	0.00
HCC071	674.83	7.13	0.02	94.69	0.00
HCC072	337.66	28.97	0.00	11.65	0.00
HCC073	941.77	34.10	0.01	27.62	0.00
HCC074	266.15	3.14	0.02	84.64	0.00
HCC075	931.73	13.59	0.02	68.55	0.00
HCC076	212.08	3.05	0.02	69.55	0.00
HCC077	1,049.49	32.89	0.01	31.91	0.00
HCC078	853.24	4.62	0.04	184.56	0.00
HCC079	1,000.98	6.36	0.03	157.32	0.00
HCC080	578.60	2.27	0.06	254.83	0.00
HCC082	791.95	2.75	0.06	288.03	0.00
HCC083	440.94	3.07	0.03	143.61	0.00
HCC084	895.28	3.19	0.06	280.79	0.00
HCC085	1,470.79	9.19	0.04	160.04	0.00
HCC086	1,445.41	4.45	0.07	324.95	0.00
HCC087	52.75	11.75	0.00	4.49	0.00
HCC088	344.81	8.86	0.01	38.91	0.00
HCC089	983.05	9.99	0.02	98.37	0.00
HCC090	584.37	5.27	0.02	110.82	0.00
HCC091	589.12	17.21	0.01	34.22	0.00
HCC092	637.05	4.55	0.03	140.10	0.00
HCC093	756.02	4.81	0.03	157.08	0.00
HCC094	1,056.97	4.57	0.05	231.29	0.00
HCC095	733.74	3.56	0.05	206.32	0.00
HCC097	414.70	3.92	0.02	105.87	0.00

Variable	Non-standardised coefficients B	Standard error	Standardised coefficients Beta	t	Significance level
HCC098	594.39	3.95	0.03	150.65	0.00
HCC099	488.75	7.08	0.02	69.04	0.00
HCC100	513.90	13.25	0.01	38.79	0.00
HCC101	415.63	8.73	0.01	47.58	0.00
HCC102	88.88	61.51	0.00	1.44	0.15
HCC103	593.57	11.84	0.01	50.15	0.00
HCC104	844.77	4.56	0.04	185.19	0.00
HCC105	574.43	3.45	0.04	166.32	0.00
HCC106	418.22	1.95	0.05	214.01	0.00
HCC107	1,342.12	18.12	0.02	74.06	0.00
HCC108	472.74	2.35	0.04	200.97	0.00
HCC109	307.89	2.26	0.03	136.49	0.00
HCC110	1,031.39	3.57	0.06	288.71	0.00
HCC111	463.78	5.84	0.02	79.36	0.00
HCC112	416.96	2.67	0.03	156.39	0.00
HCC113	420.29	1.00	0.10	419.28	0.00
HCC114	1,322.85	6.58	0.04	200.98	0.00
HCC115	478.37	1.73	0.06	277.27	0.00
HCC116	220.42	70.94	0.00	3.11	0.00
HCC117	429.58	7.50	0.01	57.29	0.00
HCC118	344.24	5.01	0.02	68.71	0.00
HCC120	474.35	18.32	0.01	25.89	0.00
HCC121	320.58	13.92	0.01	23.02	0.00
HCC122	329.91	4.69	0.02	70.29	0.00
HCC123	600.37	2.02	0.07	296.65	0.00
HCC124	338.91	2.50	0.03	135.40	0.00
HCC125	176.29	7.28	0.01	24.20	0.00
HCC126	266.88	22.82	0.00	11.69	0.00
HCC127	229.61	1.12	0.05	204.71	0.00
HCC128	19.87	28.35	0.00	0.70	0.48
HCC130	65.24	10.80	0.00	6.04	0.00
HCC131	934.98	3.40	0.06	274.81	0.00
HCC132	839.06	6.00	0.03	139.80	0.00
HCC133	1,049.78	4.63	0.05	226.53	0.00
HCC134	-11.32	26.83	0.00	-0.42	0.67
HCC135	267.25	3.36	0.02	79.62	0.00
HCC136	426.59	7.35	0.01	58.04	0.00
HCC137	-173.55	18.93	0.00	-9.17	0.00

Variable	Non-standardised coefficients		Standardised coefficients		
	B	Standard error	Beta	t	Significance level
HCC138	102.46	4.43	0.01	23.15	0.00
HCC139	3.69	5.22	0.00	0.71	0.48
HCC140	98.08	6.30	0.00	15.58	0.00
HCC141	300.02	14.65	0.00	20.47	0.00
HCC142	71.07	5.38	0.00	13.21	0.00
HCC143	10.94	4.48	0.00	2.44	0.01
HCC144	-18.87	4.51	0.00	-4.19	0.00
HCC145	-19.07	3.14	0.00	-6.08	0.00
HCC146	-6.87	6.37	0.00	-1.08	0.28
HCC147	107.38	5.26	0.00	20.43	0.00
HCC149	822.14	12.06	0.02	68.16	0.00
HCC151	-9.08	21.09	0.00	-0.43	0.67
HCC152	279.85	2.79	0.02	100.42	0.00
HCC153	185.17	2.03	0.02	91.24	0.00
HCC155	-10.58	5.00	0.00	-2.12	0.03
HCC156	-210.20	41.09	0.00	-5.12	0.00
HCC157	249.57	17.80	0.00	14.02	0.00
HCC158	164.99	6.71	0.01	24.59	0.00
HCC159	80.74	6.57	0.00	12.29	0.00
HCC160	23.96	9.06	0.00	2.64	0.01
HCC161	-156.03	27.53	0.00	-5.67	0.00
HCC162	12.39	3.06	0.00	4.04	0.00
HCC163	9.63	6.27	0.00	1.54	0.12
HCC164	355.31	6.28	0.01	56.54	0.00
HCC165	179.74	4.71	0.01	38.20	0.00
HCC166	3.55	3.11	0.00	1.14	0.25
HCC167	106.07	2.98	0.01	35.64	0.00
HCC170	256.61	4.07	0.02	63.11	0.00
HCC171	59.53	3.36	0.00	17.71	0.00
HCC172	1,096.71	123.05	0.00	8.91	0.00
HCC174	-137.88	29.87	0.00	-4.62	0.00
HCC175	-234.36	43.70	0.00	-5.36	0.00
HCC176	429.25	9.38	0.01	45.78	0.00
HCC177	547.24	31.76	0.00	17.23	0.00
HCC179	-48.22	4.10	0.00	-11.76	0.00
HCC180	19.00	9.39	0.00	2.02	0.04
HCC181	413.03	3.70	0.03	111.71	0.00
HCC182	560.02	10.34	0.01	54.18	0.00

	Non-standardised coefficients		Standardised coefficients		
Variable	B	Standard error	Beta	t	Significance level
HCC183	126.05	2.79	0.01	45.12	0.00
HCC184	-60.60	15.93	0.00	-3.80	0.00
AGE	0.13	0.01	0.00	16.10	0.00
Dependent variable: EXPEND1					

Note: Age/sex cohorts were excluded.
Source: Author's regression using SPSS.

Only 17 of the 170 HCCs diagnoses being considered are not statistically significant or are negative. Usually it is necessary to recalibrate the model when there are negative coefficients. This recalibration consists simply of eliminating those variables with negative coefficients. But, our analysis focuses on models' predictive performance and does not dwell on the statistical significance of the included variables. The specification of each model was forced; potential negative parameter estimates were not set to 0. This follows from Behrend et al., 2004.

Furthermore, the more significant or important HCC diagnoses to predict costs are Appendicitis (HCC035), Metastatic Cancer and Acute Leukemia (HCC007), Protein-Calorie Malnutrition (HCC021) Intestinal Obstruction/Perforation and Other Gastrointestinal Disorder (HCC031 and HCC036) and Viral and Unspecified Pneumonia, Pleurisy (HCC113).

3.4. Redistribution comparison

Table 56 shows the aggregated predictive ratios for ISAPREs and FONASA. The PRs show a high aggregated level of predictiveness, with a 6% overestimation among ISAPREs and only a 1% underestimation for FONASA.

Table 56: Comparison of actual versus predicted expenditures, in US dollars 2002

		Average expenditures annualised		
Group	Observations	Actual	Predicted	Predictive Ratio
All enrolees	13,098,481	8.887	8.887	1.00
FONASA	10,157,686	9.651	9.527	0.99
ISAPREs	2,940,795	6.821	7.248	1.06

Source: Author's analysis.

Table 57 shows the sum of risks by type of insurance using the DxCG model. FONASA's risk is 359% higher than that of ISAPREs. The average risk factor per insured beneficiary is 33% higher in FONASA, which means a FONASA beneficiary is 33% riskier than an ISAPRE beneficiary. In the demographic cell model this difference is only 20%. The additional 13% may be the morbidity differences between ISAPREs and FONASA, which is an indication that ISAPREs cover a healthier population.

Table 57: FONASA's and ISAPREs' risk factors, 2001

Insurer	Sum of risk factors diagnoses model	Average of risk factor by insured – Diagnoses model	Average of risk factor by insured – Sex and age model (Cell model)
FONASA	10,869,444	1.07	1.04
ISAPREs	2,368,577	0.81	0.87
% of difference	359%	33%	20%

Source: Author's analysis.

If we assume a per capita community premium equivalent to US$ 93.56 or Ch$50,000 in 2006 (as in Chapter IV, point 4.2), and we redistribute resources based on the predicted expenditures of Table 57, the resulting redistribution is shown in Table 58. This resource redistribution resulting from the diagnoses based risk adjustment model is greater than the one of the demographic cell model studied in Chapter IV. In fact, ISAPREs compensate FONASA with US$ 55.87 million. This represents 4.6% of the Fund's resources and 75% of the ISAPRE system's total profit in 2006.

Table 58: Estimation of aggregated redistribution from ISAPRE to FONASA with diagnoses-based risk adjustment model, US dollars 2006

	FONASA	ISAPREs	Total	Mean
Population 2006	10,157,686	2,940,795	13,780,432	
Community premium	93.56	93.56		93.56
Total Resources	950,328,949	275,133,787	1,225,462,736	
Premium subsidy	100.11	75.35		93.56
Adjusted total amount	1,006,200,108	219,262,628	1,225,462,736	
Redistribution from ISAPREs to FONASA	55,871,160	-55,871,160	0	

Source: Author's calculations

The diagnoses-based model we propose captures a great part of the morbidity of health, unlike the models restricted to the GES health problems from Chapter IV. If we include in our simulation the total expenditure on health care services for both FONASA and ISAPREs and not only for GES health problems, the redistribution from the ISAPREs to FONASA could be as high as US$ 162.79 million. This would be equivalent to 30% of the public expenditure on primary health care in 2006, 9.4% of ISAPREs' operation income and double its profit in 2006.

VII. Conclusion and discussion

We analyse the most important economic and financial aspects of the health care system in Chile and propose a model that solves the efficiency, equity and lack of solidarity problems that we currently see in the system.

Similar international experience, especially in Europe, focused on the risk selection concern, the removal of beneficiaries, and the inequities that these concerns generate. Europe has taken strong steps towards finding solutions to these problems, beginning with a systematic diagnosis of the situation. This work attempts to replicate those efforts in terms of the use of tools and relevant concepts for the Chilean case.

In a competitive health insurance market, without proper regulation, the risk premium is high for the elderly, the sick, women of fertile age, and large families. The risk premium is low for the young, single, and small families. This is what we currently see in the case of ISAPREs in Chile.

Furthermore, Chile has significant inequities in the health financing between the public and private sectors, and between the high and low income quintiles. The institutional arrangement separates financing of the public insurer FONASA (which includes funds from treasury and contributions made by the low-income population) and the individual ISAPREs (which includes contributions from the 20% highest income population). On the other hand, the high co-payments and out-of-pocket expenditures of the population weaken the necessary financial responsibility of insurers. The beneficiaries' expenditures should be reflected in the financial performance of the insurance companies and not in the financial performance of the individuals or public institutions.

Making insurance mandatory and having income-based premiums are the typical mechanisms countries implement to promote solidarity in the health system. It promotes premiums that are independent of the health status of individuals, of the number of family members, their income and of the risk of falling ill. Initially, this is the fundamental technical reason for the way premiums are set in Chile, as is the case in many other countries with a social security system.

When the premium is restricted because it is based on income, to avoid regressiveness in the mandatory contribution to social security, it gives rise to risk selection incentives. The elements that give incentives to risk select are reinforced under weak regulation. In fact, in the Chilean case there are high inequities in financing, a large selection problem and a segmented health system, all of which remain even with the current reform.

In Chile, as in other countries, risk selection generates many types of inefficiencies. First, ISAPREs do not have the incentive to respond adequately to the needs of high risk affiliates, possibly giving rise to a treatment quality problem, for example, for the chronically ill. Second, ISAPREs' success in attracting low-risk individuals generates a segmented market, where low premiums are charged to low-risk individuals and high premiums are charged to high-risk individuals, and no private health insurance plan is designed for income levels below a certain threshold. This generates a solidarity problem for the social security system. Furthermore, important groups of people are affected by ISAPREs' cream skimming practices. For example, individuals who cannot afford ISAPREs' high premiums end up switching to FONASA where they pay the lowest premium possible (7% of their income) for reasonable coverage. The net effect of this for FONASA is a financial deficit that has to be covered with resources from contributors or the Government, which leads to an equity problem. In the previous example, the resources available decrease for the group of beneficiaries who were in the system before the entry of a high-risk individual, who have, up to that point, contributed their premiums to the private system.

In this context, selection is more profitable for ISAPREs than improving efficiency in the production of health care services. In the short term, insurance companies prefer to invest their available resources in improving risk selection and not in reducing costs, and so they do not invest in improving efficiency in the provision of care. Hence, it could be the case that the more efficient insurance companies which implement less risk selection run the risk of losing market share relative to those insurance companies that are less efficient. Although a single ISAPRE may gain from selection, it is still a loss for society and hence a total welfare loss. This is also an example of how selection could work against efficiency.

One way to reduce risk selection is to create premium cross-subsidies from low-risk groups to high-risk groups (van de Ven et al, 2001). This model would make solidarity subsidies effective, without hindering the competition within the ISAPRE system. This may be done through a risk adjustment model that uses the available information to estimate expected health costs for an individual or group, based on utilization and observed costs during a fixed period of time, to establish the subsidy for the high-risk group. Risk adjustment is expected to neutralize incentives for risk selection to the extent that insurers become indifferent to who becomes a beneficiary. These policies could be implemented in Chile, and because FONASA is a large public insurer that coexists with private insurers, including it in the risk adjustment model differentiates Chile from the international experience. It is important to keep in mind this particularity when adapting the model to the Chilean case, and to ensure the financing of at least those individuals who are not able to pay for insurance elsewhere.

In general, there are a set of other policies that could accompany risk adjustment models. An important one is open enrolment which would play a complementary role to risk adjustment. In practice, only FONASA has open enrolment, which is only sustainable through the supply subsidy given by the Government to the public health sector. Without open enrolment in the private health insurance sector, risk adjustment becomes even more necessary.

Therefore, besides risk adjustment, a minimum regulatory framework is necessary with a minimum set of regulations: open enrolment, minimum contract duration (5 years, for example), guaranteed contract renovation and no risk re-evaluation at the conclusion of the first contract.

In sum, in a scenario with many market failures, as is the case with the health care sector, there is a trade off between equity and efficiency, which is a key challenge faced by governments and technical regulatory institutions. The redistribution of risks −from the young to the elderly, and from the healthy to the sick− may improve both of the relevant concepts of health policy − equity and efficiency. We can conclude that the better the quality of risk adjustment, the lower the trade off between equity and efficiency.

To reach the level of sophistication required by the proposed adjustment models based on diagnoses, we explore the available datasets and use the only existing individual dataset available: hospital discharges at the national level. At the same time, and taking advantage of the good quality of the dataset, we estimate costs for each discharge and impute them into the dataset, following previous studies. Due to ID problems, however, only 36% of the cases were verified. After performing the relevant tests to interpret the level of representation of this sample, we conclude that it is sufficient. Because we had access to information for only one year (2001), the study was limited to a concurrent model.

We review various risk adjustment models for the private and public sector, considering that FONASA is expected to subsidize the poor. This study reviews the model implemented in the reform and its limited impact. The originally proposed compensation fund −which was rejected in Congress− included solidarity between both sectors, but was also limited to the reduced basic package in GES. Given this, we go beyond the simple cells-model and present a regression model that in the first stage uses demographic adjustment and then incorporates morbidity. Our results show that the model incorporating morbidity is far superior to the previous alternatives. When the effects of redistribution are simulated on the financing of health services, redistribution towards FONASA is highest to one of the actuarial demographic models. But the model recognizes the current and expected morbidity based on diagnoses of the public insurance, which has been the recipient of the "bad risks" from the ISAPRE system for many years.

We argue that the more refined the adjusters, the more accurate the predictions of medical expenditure, hence decreasing the selection incentives.

We compare the two concurrent risk adjustment regression models: the demographic model that predicts costs based only on sex and age; and the diagnosis-based model, which incorporates health conditions grouped as the Hierarchical Condition Category of the Diagnosis Cost Group Classification System (DxCG/HCC). We compare them based on their ability to predict the current health care costs.

A concurrent application uses claims data from a period of time to project medical claim costs for that same period. The risk weight reflects an estimate of the marginal cost for a given medical condition relative to the base cost for individuals with no medical conditions.

To predict expenditures at the individual level, we use linear formulas obtained from an Ordinary Least Squares (OLS) regression to combine the expenses associated with diagnostic groupings (HCCs) and age/sex cohorts.

We measure the individual level predictive performance using individual adjusted- R^2 and the mean absolute prediction error (MAPE). We assess the group level predictive performance using predictive ratios (PR) of expenditure quintiles. The adjusted-R^2 measures the model's fit and describes the percentage of the individual variance in actual expenditure explained by the model. MAPE is the mean of the difference between actual and predicted expenditures for all individuals. The predictive ratio of expenditure quintiles is a group measure calculated as the ratio or the aggregated predicted expenditure for a given group of beneficiaries, over the aggregated actual expenditure for the same group of people.

Based on adjusted-R^2, the demographic model explains only 2.6% of the variance in total actual expenditure. When we include a dummy for hospitalisation, we achieve an adjusted R^2 of 21.5%. The third model uses morbidity and has an adjusted-$R^2$of 36.1%; the predictive performance of this model represents a 68% of improvement over the demographic model with hospitalisation and performs 14 times better than the demographic model.

For the same three models, MAPE provided equal ranking, where the recalibrated DxCG/HCC model (with morbidity) was US$ 6.06 in the best model, 23% more than the demographic model.

The relative rankings of the models remained unchanged when their concurrent predictive performances for groups of enrolees with relatively high, medium and low expenditure were evaluated. The PR results for enrolees grouped by quintiles of actual expenditure shows that the demographic model is grossly underpaying the lowest expenditure quintile. The demographic model with a dummy variable for hospitalisation and the diagnosis based model overpay the lowest expenditure quintile and underpay the highest expenditure quintile. The recalibrated DxCG/HCCs model performs even better, though there is still overpayment for the lowest expenditure group of insured and underpayment for the high expenditure groups.

In conclusion, the introduction of risk adjustment is necessary in Chile. An age/sex based risk adjustment model is inadequate because it considers too few relevant patient characteristics. Additionally, we show here that only a small part of the variation in individual resource use is explained. When the model is used for payment, it encourages favourable selection and causes access problems. Instead the diagnoses-based risk adjustment model can distinguish differences in expected costs concurrently and explain more and better the variation observed in health spending across individuals. Hence this model is proposed as the best alternative for Chile.

Regardless of the good results obtained, important problems remain that may limit its application in practice, assuming the political will to implement it. In strictly technical terms, the model requires improving the data available for the entire insurance system (FONASA and ISAPREs) at the individual level that registers systematically all patient health service utilization in the system at all service levels. On the other hand, the registry must be systematic so that it may be used in prospective models that have reportedly generated better incentives for efficiency. Also, special attention must be given to ambulatory care and drugs, to be able to estimate the ambulatory component of health care, which we were not able to include in this paper.

While the political and institutional support is obtained to implement a complete and broad model such as the one proposed here, steps forward may be taken with complementary policies like open enrolment and risk-sharing for high risk and high cost individuals, without great difficulty.

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112. Superintendencia de Salud (2007). Circular IF/N° 36. Imparte Instrucciones sobre el Fondo de Compensación Solidario. www.supersalud.cl

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www.minsal.cl

www.FONASA.cl

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www.bcentral.cl

www.ine.cl

www.dimdi.de

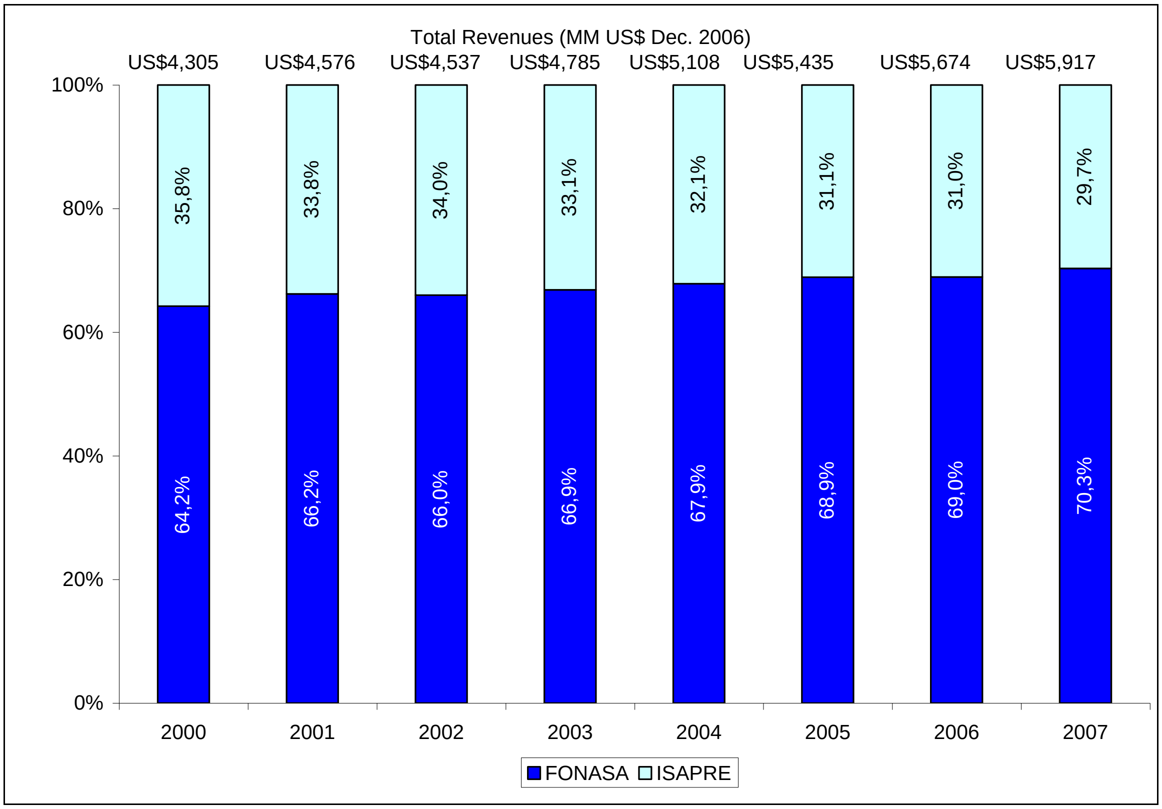
APPENDIX: COMPLEMENTARY INFORMATION ABOUT THE CHILEAN SOCIAL HEALTH INSURANCE SYSTEM

Appendix Table 1: Public sector expenditure and GDP

Year	GDP	Public Expenditure	% of GDP	Treasury Expenditure	% of GDP
2000	102.539	3.091	3,01%	1.484	1,45%
2001	107.125	3.379	3,15%	1.585	1,48%
2002	110.943	3.319	2,99%	1.487	1,34%
2003	121.128	3.419	2,82%	1.603	1,32%
2004	134.758	3.722	2,76%	1.852	1,37%
2005	147.652	3.963	2,68%	1.929	1,31%
2006	168.829	4.547	2,69%	2.284	1,35%
2007	172.724	4.836	2,80%	2.560	1,48%
2007/2000	1,68	1,56		1,72	

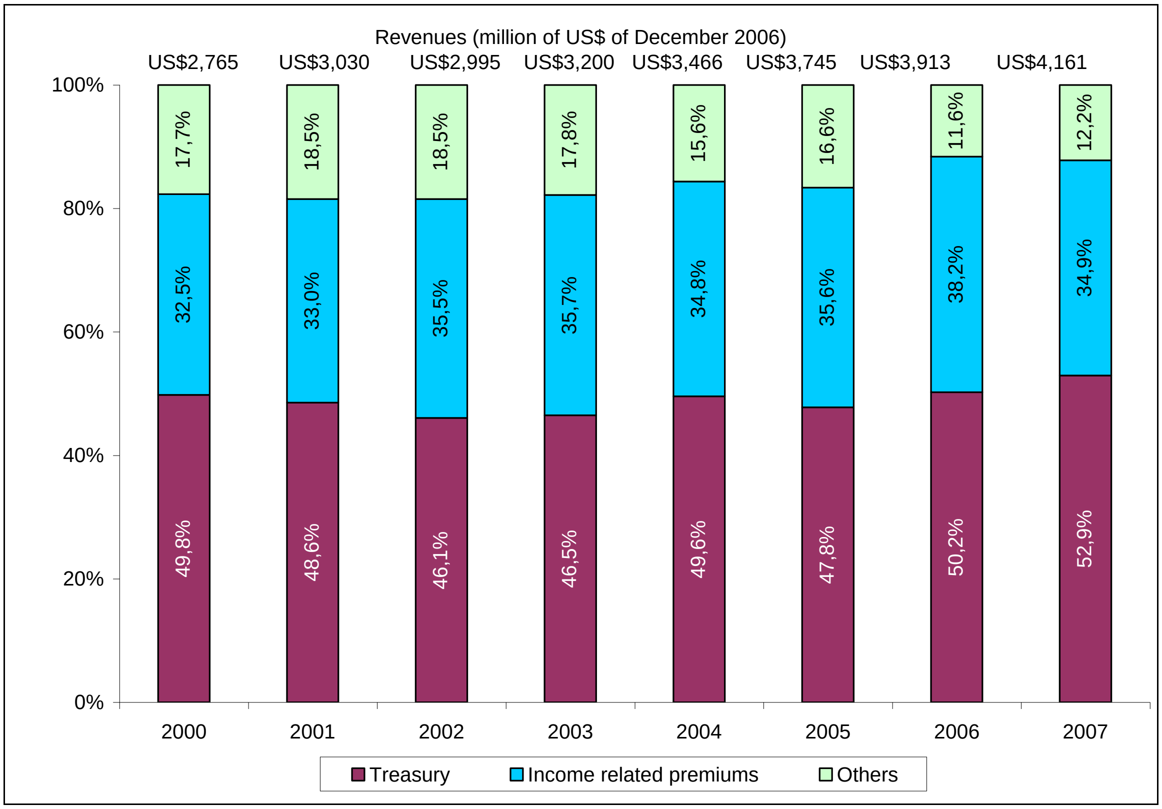
Source: Elaborated by the author using FONASA information.

Appendix Figure 1: Total revenues, FONASA and ISAPREs, 2000-2007



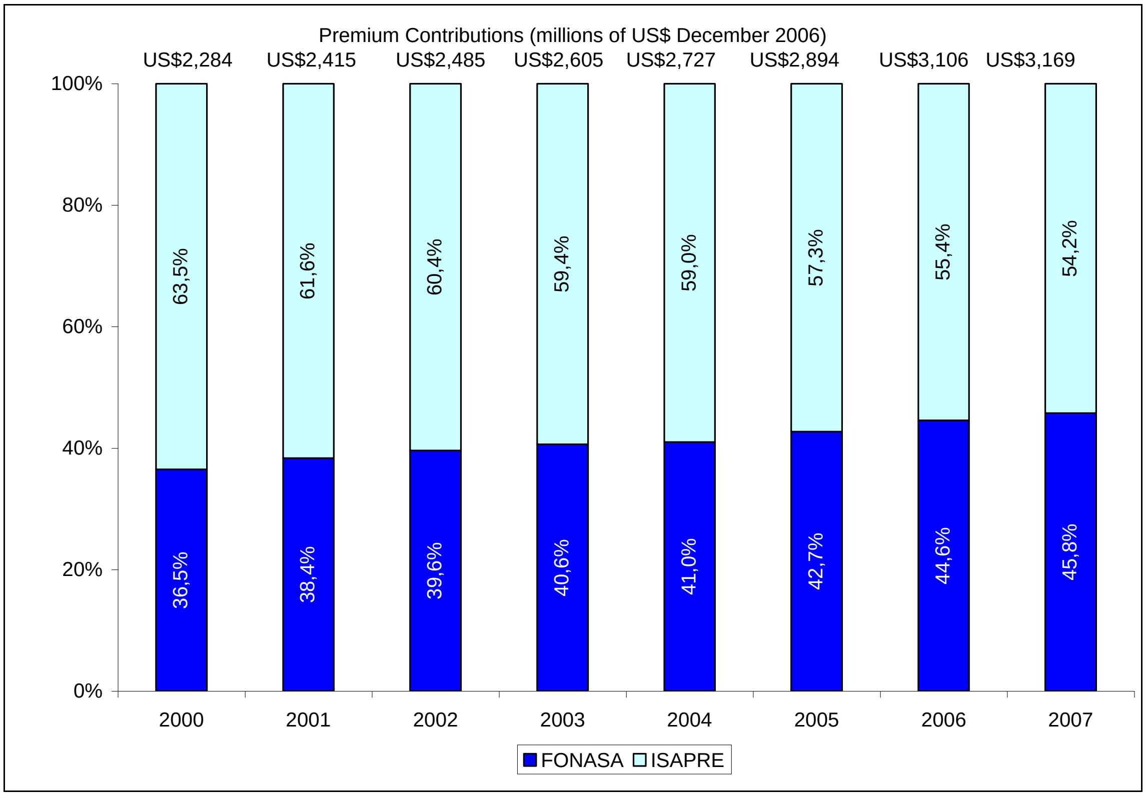
Source: Elaborated by the author with information from the Superintendence of Health using an exchange rate of $534.43/USD.

Appendix Figure 2: Revenues in the public health sector, 2000-2007



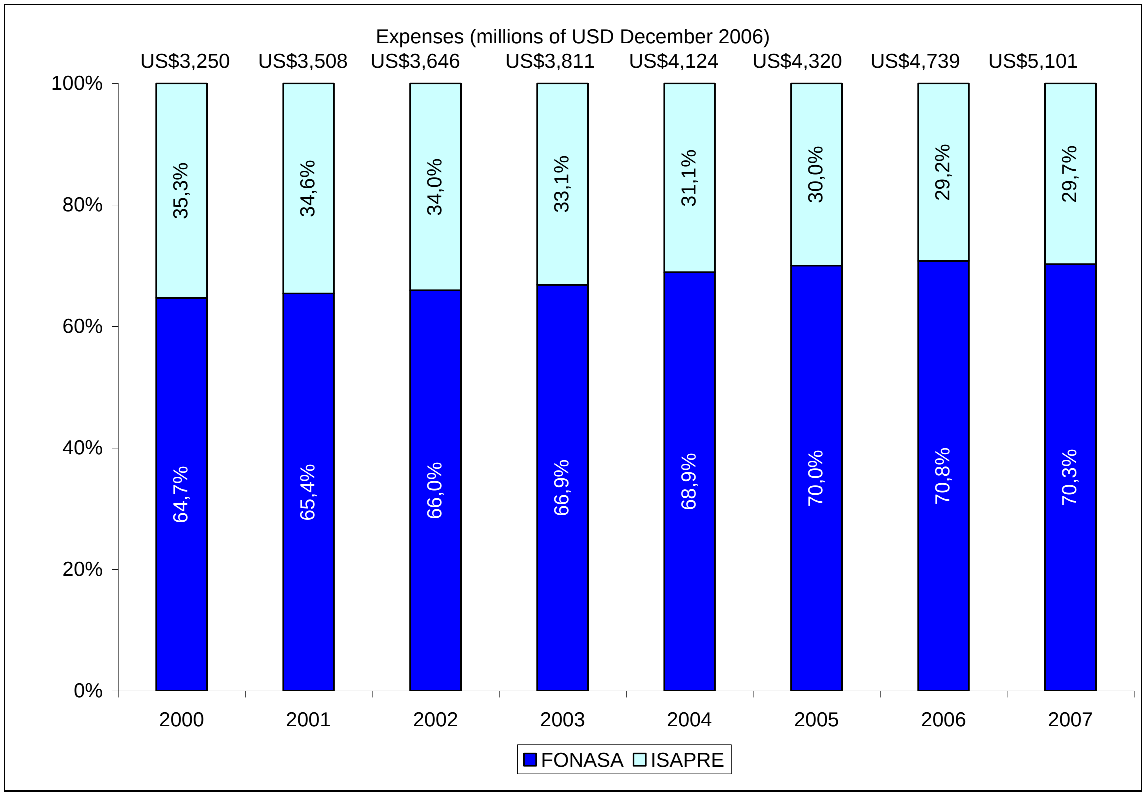
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 3: Premium contributions, FONASA and ISAPREs, 2000-2006



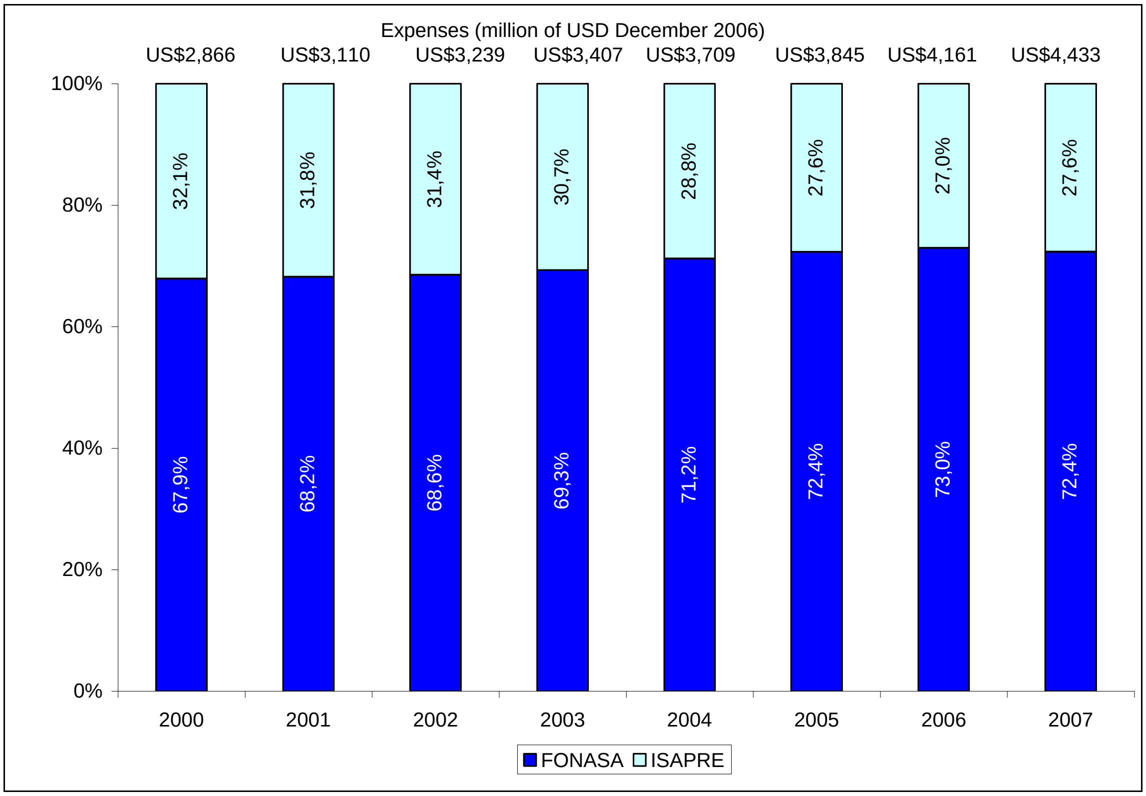
Source: Elaborated by the author using information from the Superintendence of Health

Appendix Figure 4: Total expenditure, FONASA and ISAPREs, 2000-2007



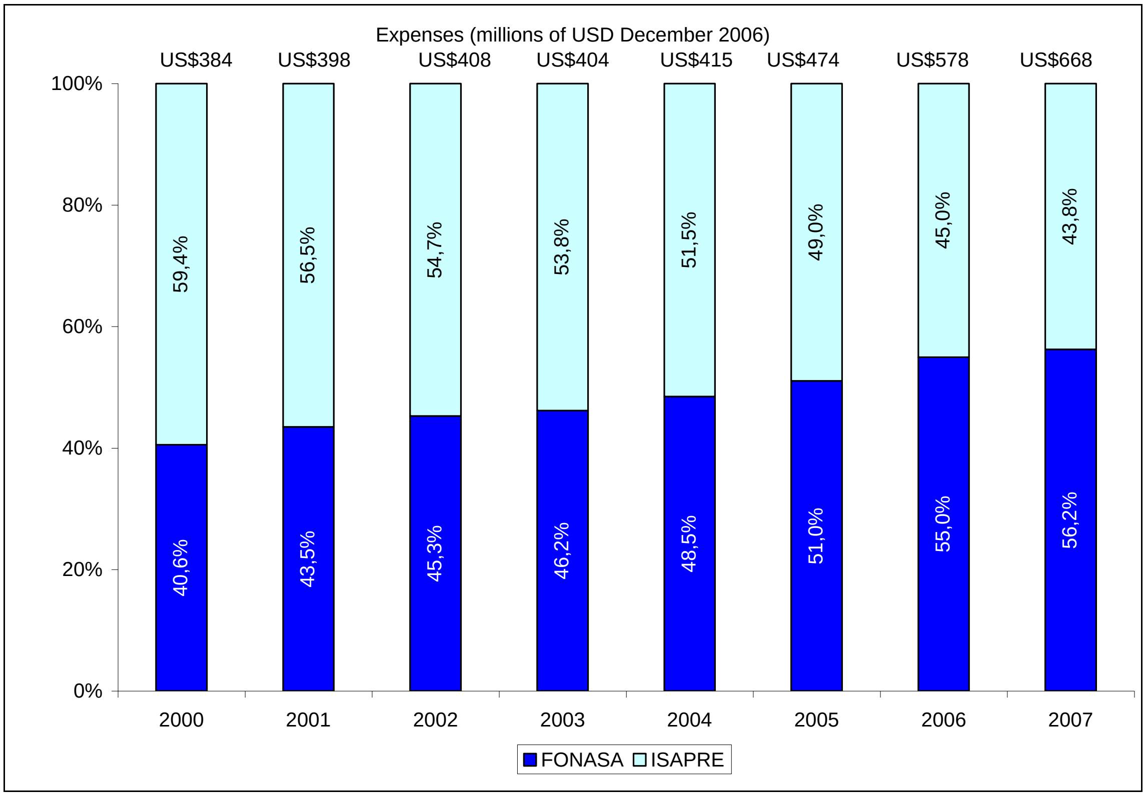
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 5: Total expenditure in health care, FONASA and ISAPREs, 2000-2007



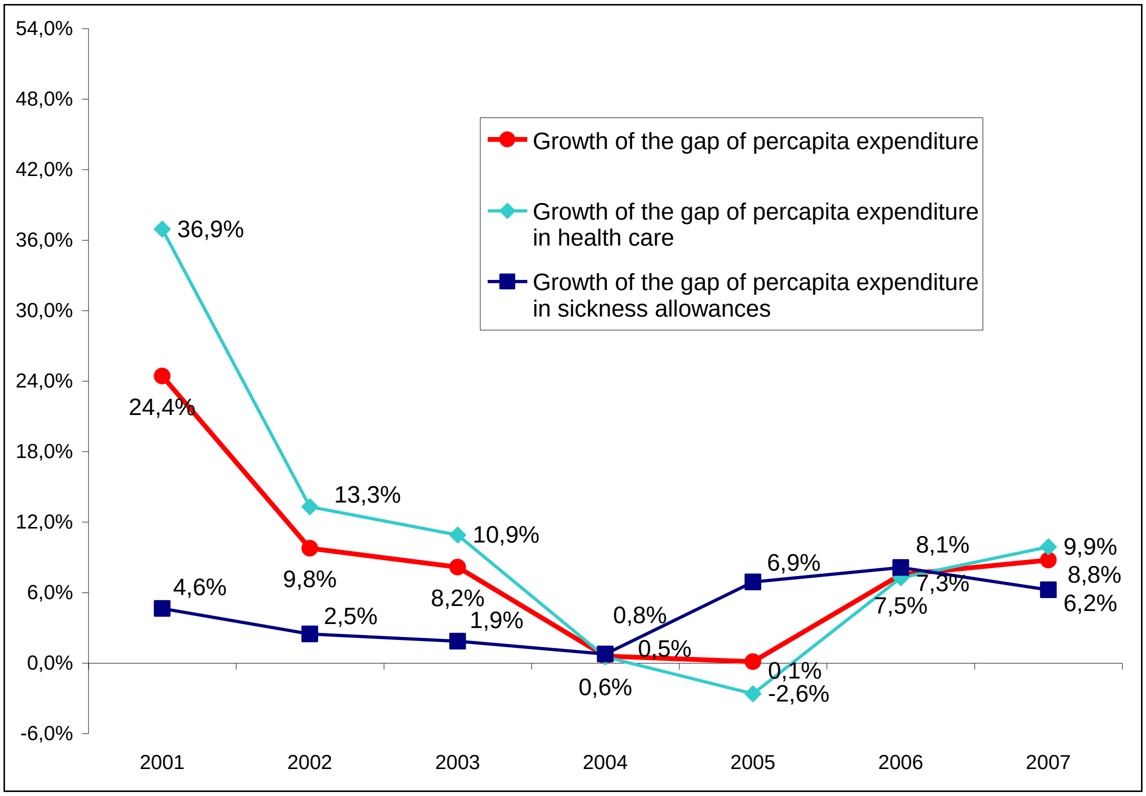
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 6: Total expenditure in sickness allowances, FONASA and ISAPREs, 2000-2007



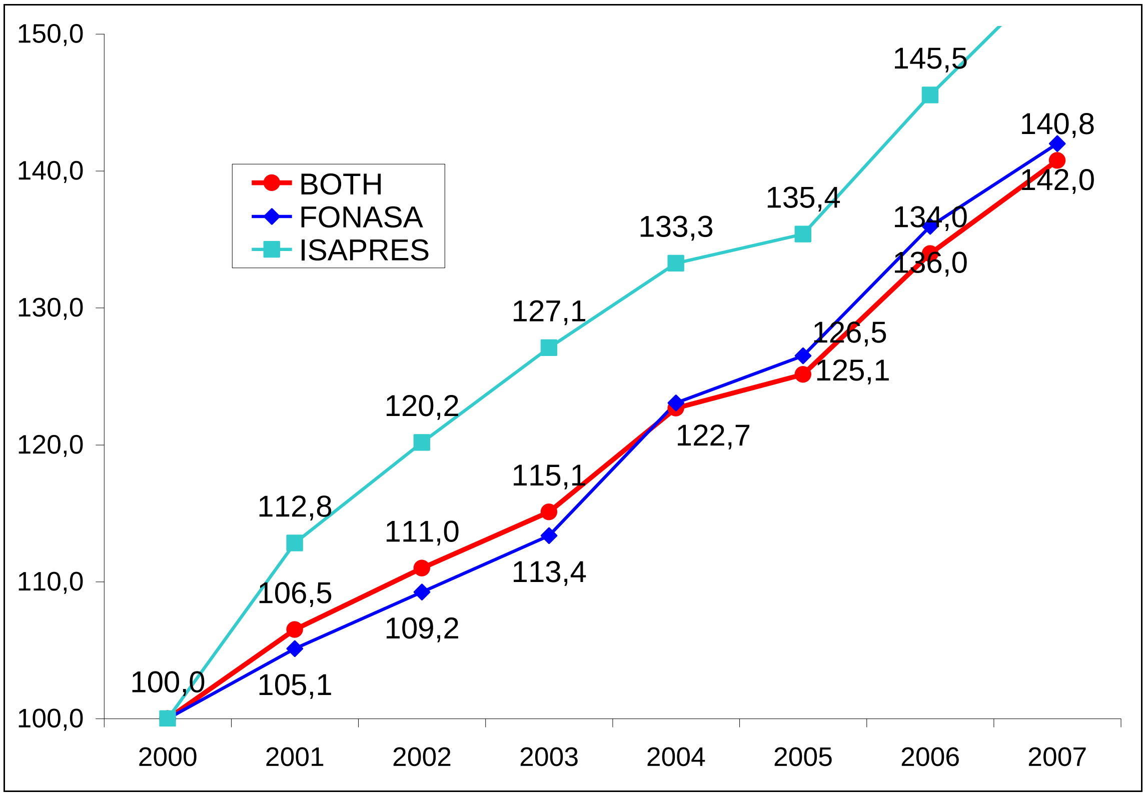
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 7: Growth of the gap of per capita expenditure between FONASA and ISAPREs, 2000-2007



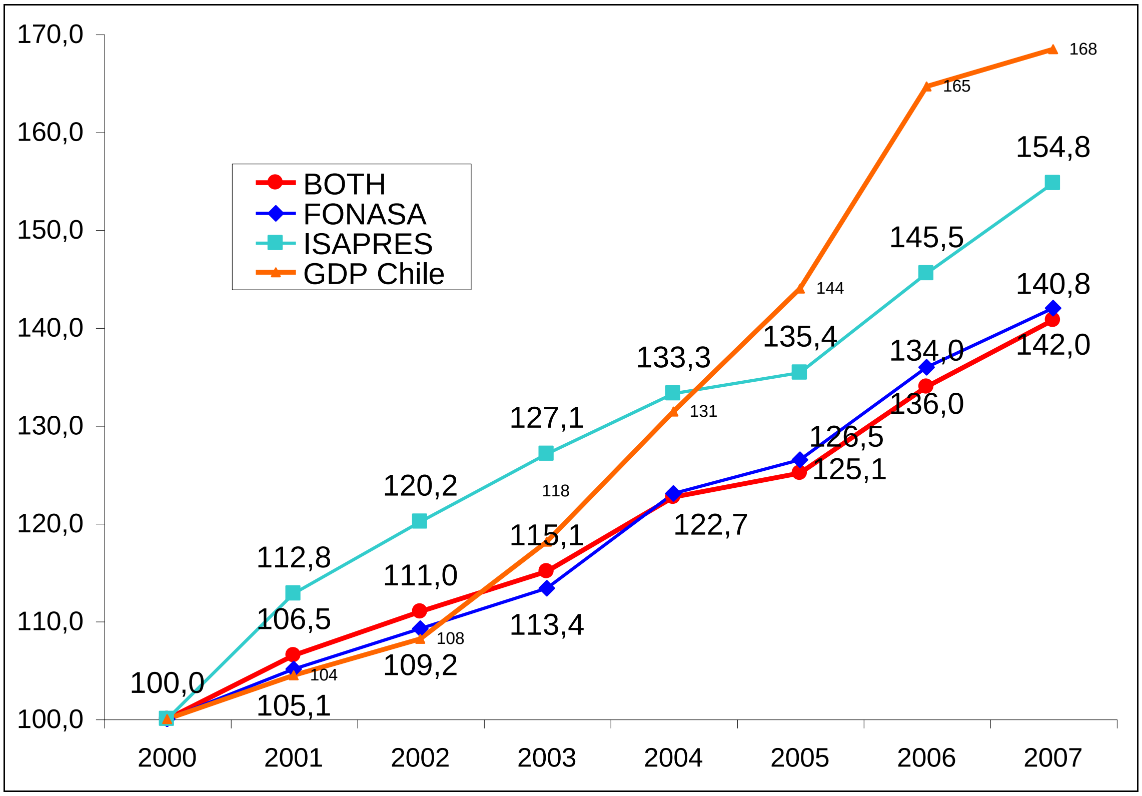
Source: Elaborated by the author using information from the Superintendence of Health

Appendix Figure 8: Growth of per capita expenditure of FONASA and ISAPREs, 2000–2007 (base year 2000)



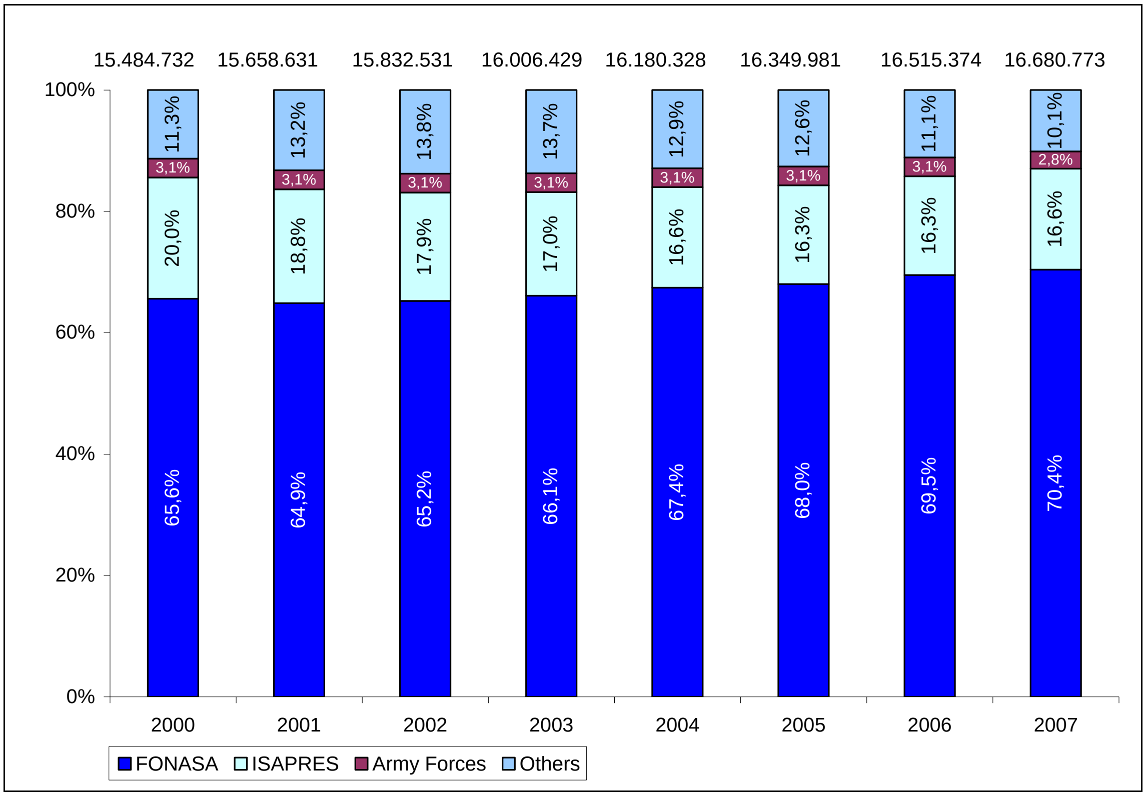
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 9: Growth of per capita expenditure of FONASA and ISAPREs versus growth of Chile's GDP, 2000-2007 (base year 2000)



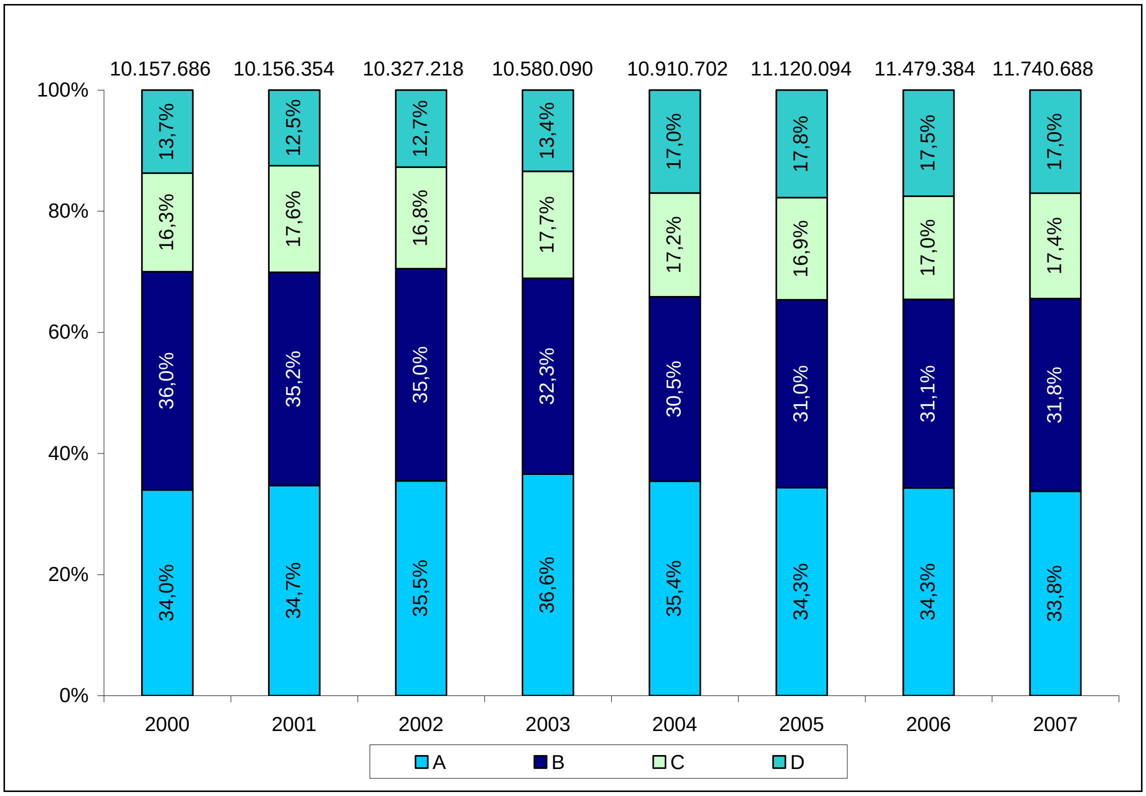
Source: Elaborated by the author using information from the Superintendence of Health and the Central Bank

Appendix Figure 10: Population of Chile by health system, 2000-2007



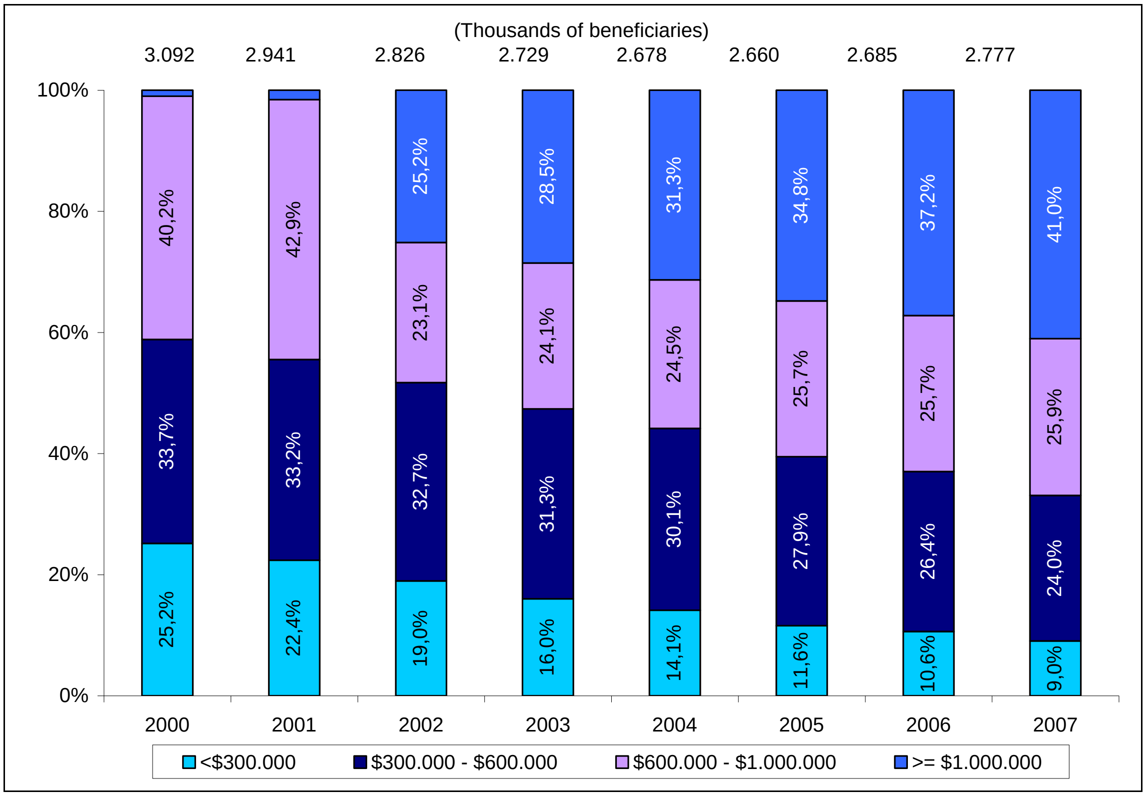
Source: Elaborated by the author using information from the Superintendence of Health

Appendix Figure 11: Beneficiaries of FONASA by income group (A poorest to D richest), 2000-2007



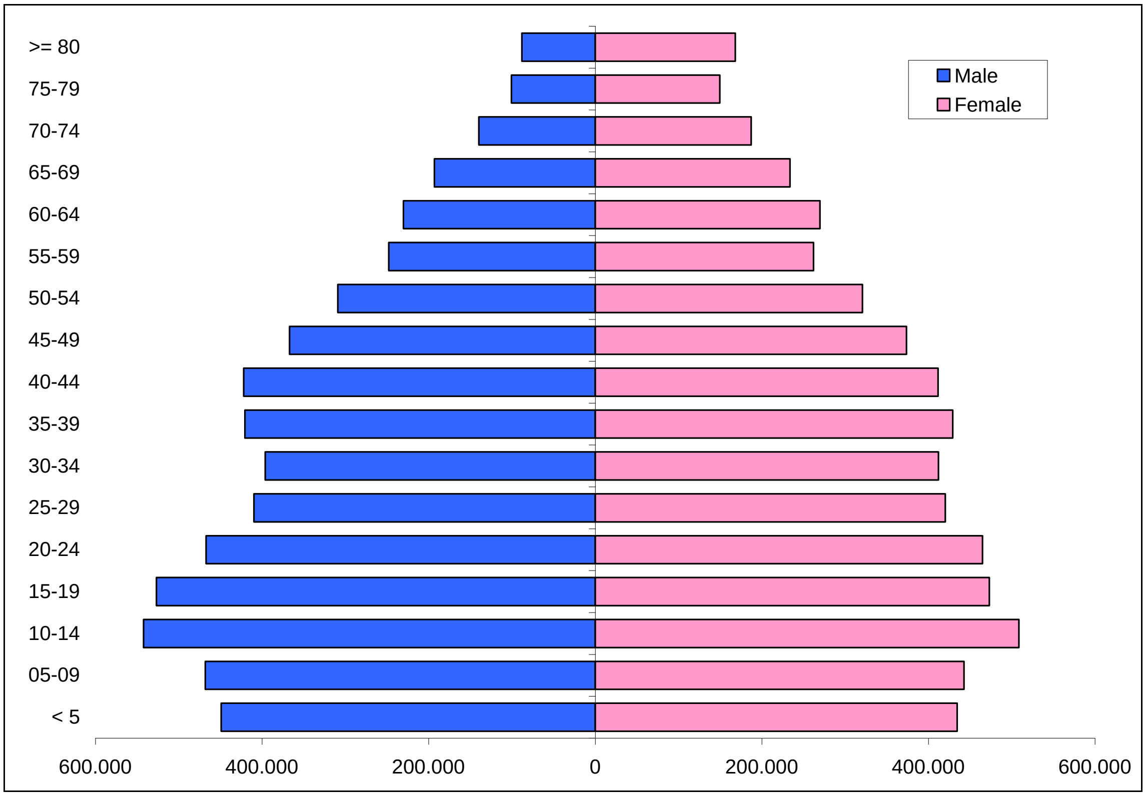
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 12: ISAPREs' beneficiaries by income group, 2000 - 2007



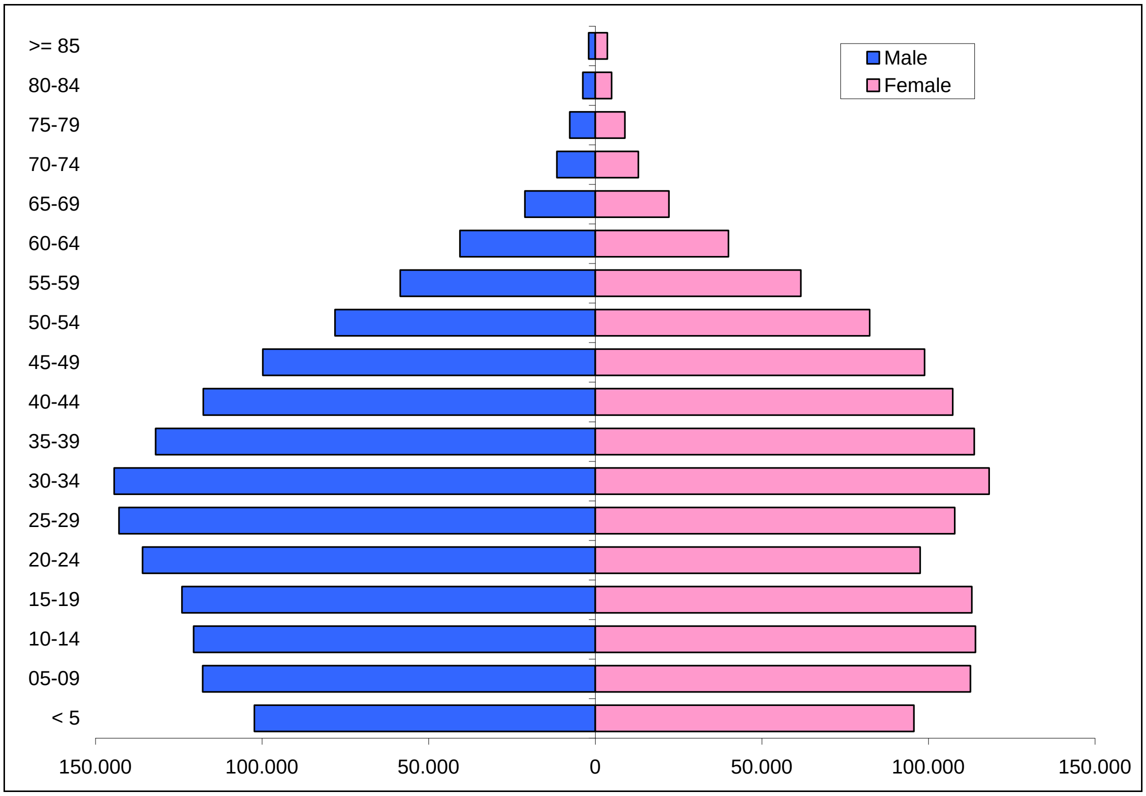
Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 13: FONASA population, December 2007



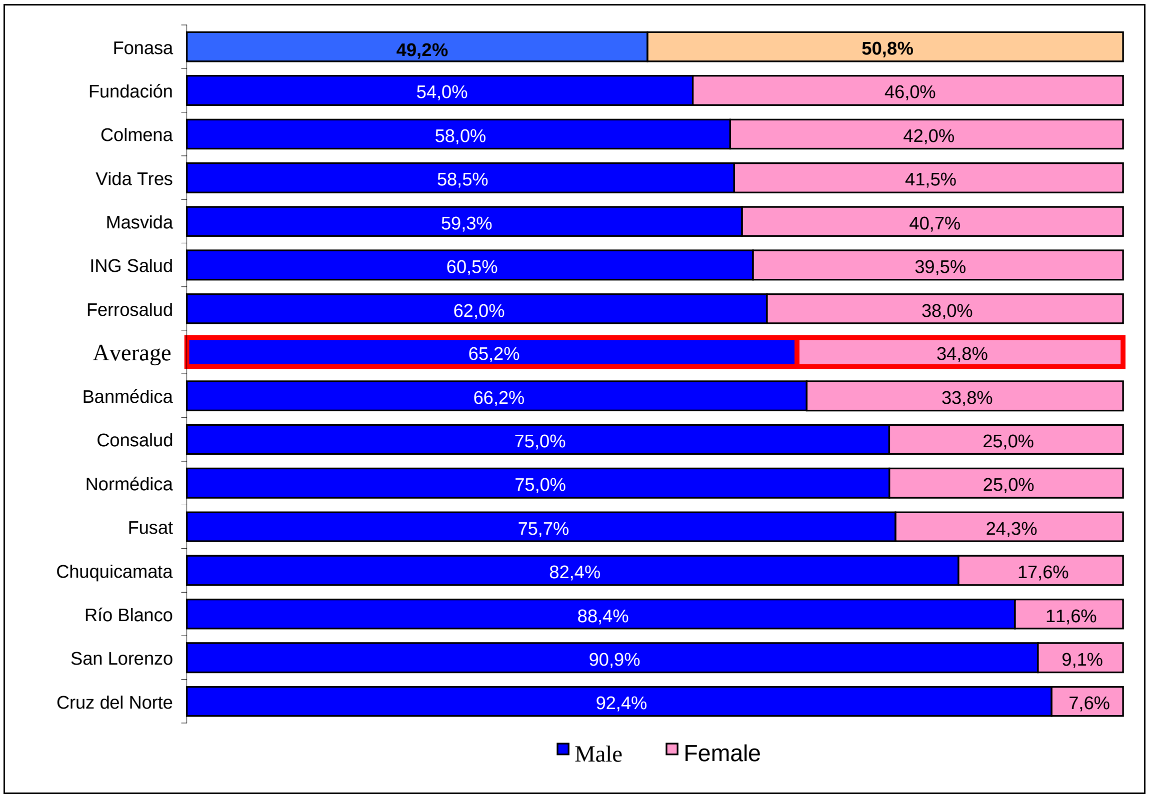
Source: Superintendence of Health.

Appendix Figure 14: ISAPREs population, December 2007



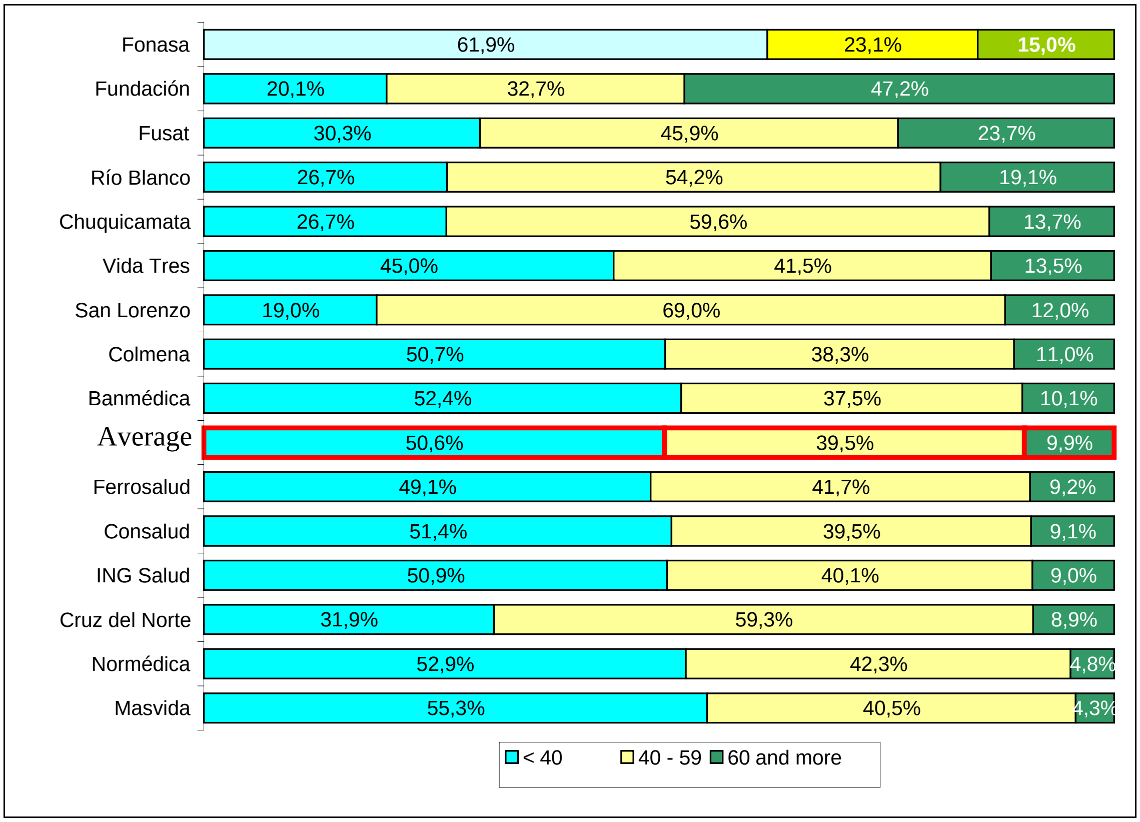
Source: Superintendence of Health.

Appendix Figure 15: Percentage of beneficiaries FONASA and ISAPREs, by sex, December 2007



Source: Elaborated by the author using information from the Superintendence of Health.

Appendix Figure 16: Percentage of FONASA and ISAPREs beneficiaries, by age groups, December 2007



Source: Elaborated by the author using information from the Superintendence of Health