Title

The Impact of Disease-Specific Health Insurance Reform on Mortality and Healthcare

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Publication Date

2023

Peer reviewed|Thesis/dissertation

The Impact of Disease-Specific Health Insurance Reform on Mortality and Healthcare

by

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A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Demography

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor William H. Dow, Chair
Professor Ronald D. Lee
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Spring 2023

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Abstract

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This dissertation examines the impact of a healthcare reform that aimed to provide universal access to care for a specific set of diseases in Chile. By investigating the impact of the Explicit Health Guarantees program on mortality and health care outcomes, we hope to contribute to understanding the effectiveness of alternative health reforms and their potential for improving health outcomes in Latin America and beyond. The findings are based on Chile's complete death and inpatient records and a difference-in-differences research design. The study reveals a 4.4% decline in deaths from the diseases covered by the reform, with a more significant effect observed in diseases that are more responsive to healthcare, declining by 7.1%. The reform resulted in over 1,000 deaths averted per year. Furthermore, the reform led to a 16.3% increase in surgeries and a 6.9% decrease in in-hospital deaths related to the covered conditions. Falsification models find no significant mortality effects on these covered diseases in other Latin American countries in these same years, thus strengthening the causal interpretation of our findings. Finally, we focus on socioeconomic, demographic, and geographic patterns of the reform's effects. The study found that public healthcare providers' patients benefited more than private clinics, which helped narrow some of the well-known socioeconomic disparities. Although the reform targeted sex-specific diseases, the study found no significant differences in the mortality reduction by sex, but important differences between age groups. Notably, and despite the fact that the increase in surgeries is similar for those between 0 and 49 and those above 80, the proportionate decrease in deaths between ages 0 and 49 was almost four times larger than the decrease in deaths among those above 80. In addition, the study found that the reform did not significantly affect deaths in

the Capital city, which had the best pre-reform access to care but decreased deaths elsewhere. Overall, the reform led to a 0.29-year increase in life expectancy.

Acknowledgments

I will always be thankful to have had Will Dow as my principal advisor for his rigorous guidance and kind mentorship like I never had before. My admiration for his dedication, intelligence, and work ethic were crucial in supporting my research. I also thank Ron Lee for sharing his vast experience, knowledge, and wisdom about the fundamentals of what an economic demographer must be, and Josh Goldstein for his sharp feedback and the opportunity to work at the highest level as a research and teacher assistant. Their generosity and brilliance were invaluable to me.

I am also grateful to my coauthor and friends for their good advice when I needed it. I thank Pablo Muñoz for his thoughtful insights throughout this journey, personally and academically. I consider myself lucky to have such a nice and bright coauthor and for setting an example of hard work to follow. Many colleagues and friends also deserve recognition. I thank Mathieu Pedemonte, Natalia Garbiras, Andrea Miranda-Gonzalez, Joel Ferguson, Ethan Roubenoff, Tristan, Tatiana Reyes, Daniela Reyes, Julio Rodriguez, Matías Morales, Maria Victoria Barone, and the Berkeley Demography Student and Staff. I will always be especially indebted to Sofía Jordan, who, for most of this journey, gave me strong support, encouragement, and a good heart; without her, it would not have been possible to achieve this. I cannot thank her enough. Finally, I thank Milo, my puppy, for patiently waiting for his daily walk while I worked.

Financial assistance from the Becas Chile program from the Chilean Government, the Department of Demography, and the John L. Simpson ABD Graduate Students Research Fellowships in Global, International, and Area Studies made my research possible. These scholarships significantly improved the quality of my life, and I am grateful to these entities. I also thank Will and Josh for offering me research assistant jobs, and Magali Barbieri from the Human Mortality Database for trusting me with research jobs when I needed them the most.

Lastly, I thank my family for their unconditional support. My sister provided me with the finest example of first-generation college graduates in my family, and my brother-in-law always had good advice. I thank my father, Fernando, for teaching me the value of hard work, and my mother, Aurora, for her determination to pursue a better life. Despite all odds, she managed to work, feed, clothe, and educate her children. I dedicate my dissertation to her for her many sacrifices and unconditional love.

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Chapter 1

Health Reforms and Mortality: Literature and Data

1.1 Introduction

Recent studies have suggested that expanding insurance coverage has beneficial effects on mortality in the United States (Sommers; Goldin, Lurie, and McCubbin; Borgschulte and Vogler; Miller, Johnson, and Wherry). Regarding Latin America, there is some evidence for the impact of health care reforms on mortality (Arroyave et al.; Parker, Saenz, and Wong). However, all of these studies focus on the early effects of expanding the proportion of the population covered by any health insurance - in some cases only targeting the old age population - rather than expanding the types of care covered, and little is known about the effects of guaranteeing timely coverage for specific diseases.

Moreover, health outcomes are often closely linked to social and economic factors, and significant spatial and economic differences in life expectancy have been observed in Latin American cities (Bilal et al.). This highlights the importance of area-based approaches and policies that address social inequalities in improving health outcomes in cities across the region.

Despite the importance of alternative health reforms, there have been methodological constraints and a lack of data, limiting research on their impact (Levy and Meltzer; Moreno-Serra and Smith; Gruber and Sommers; Black et al.). Specifically, the absence of quasi-experimental variation in healthcare access that is independent of insurance type has been a key limitation.

To address this limitation, this study examines Chile's most significant health insurance reform in the past 30 years: the Explicit Healthcare Guarantees program

(known as "GES" for its name in Spanish). This reform provided universal access to care for a specific set of diseases, independent of insurance type, and is a unique case to study the impact of guaranteeing timely access to care for specific diseases. By investigating the impact of the GES program on mortality and other health outcomes, we hope to contribute to understanding the effectiveness of alternative health reforms and their potential for improving health outcomes in Latin America and beyond.

Previous work on this Chilean reform shows early success in reducing myocardial infarction mortality (Nazzal et al.). It also suggests that it may have improved access to health care and health status, especially among lower-income Chileans (Frenz et al.).

1.2 The Explicit Health Guarantees (GES) Insurance Reform

The Chilean Health Care System

Chile has experienced rapid economic growth since the mid-1980s, with a GDP per capita of nearly $28,500 in 2022, the highest in Latin America. The sustained economic growth has positively correlated with health outcomes over the past decades: life expectancy, avoidable mortality, chronic disease morbidity, and self-rated health is near the OECD average and above the Latin American average (OECD, 2021). However, economic growth benefits have not been accrued to everyone equally. Chile's Gini index of 0.49 in 2017 was the second highest among OECD countries.

In the mid-80s, under dictatorship rule, a two-tier system was introduced: it stipulated a mandatory 7% contribution for workers in the formal economy who would pay into the public system but who could choose to opt-out and use the 7% for private health insurance instead. The *Fondo Nacional de Salud* (FONASA)'s public system is funded by taxes and mandatory contributions. It offers care mainly in public hospitals to everyone that requires it, with three levels of copay (0, 10, or 20%) based on the patient's income and their number of dependents.[1] Private insurance providers, *Instituciones de Salud Previsional* (ISAPREs), offer health plans for different prices and compete in a highly regulated market to attract those who

[1]It is worth mentioning that *within* FONASA, there is an option to facilitate access to care known as the Free Choice Modality (*Modalidad de Libre Elección - MLE*). This option allows users in the high-income segment to use private providers while incurring an increased copayment percentage.

have chosen to use their mandatory contributions in private insurance over the public system. Nearly 78% of the population contributes to and uses the public system while ISAPRES only covers around 17-18% of the population. The remaining 3-4% are covered under an Armed Forces insurance scheme. Moreover, FONASA serves lower-income people with a higher risk of disease and health-related issues, while ISAPRES covers the wealthier, healthier, and younger population (Pardo).

The public sector provides healthcare services through a network of facilities ranging from locally run primary care centers to nationally administered specialty hospitals present throughout the country. Primary healthcare centers perform low-complexity procedures and preventive services, usually in nutritional and reproductive health. Laboratory and other primary services, such as pap smears and dental care, are also available. Patients will be referred to the closest regional hospital for more complex treatment and procedures.

The private sector includes private healthcare facilities ranging from individual doctors' practice to large integrated systems that offer highly specialized medical care to their contributing members and the public. However, as is the case in most Latin American countries, the private healthcare provider market is highly heterogeneous regarding clinical and operational procedures, integration of care, and organizational arrangements.

The Explicit Health Guarantees (GES) Reform

The GES reform was conceived in 2001 as part of major reform for the Chilean Health System toward achieving "effective" Universal Health Coverage. It was a novel effort to expand access and financial coverage, improve quality, and provide timely care administration for specific health-related problems with high mortality, morbidity, and financial impact (Vargas and Poblete). Although these health conditions were previously covered in public and private systems under the government's universal health care policies, the GES reform ensured and guaranteed timely access to high-quality care for top priority conditions (Erazo), including heart attacks, ischemic stroke, hypertension, diabetes, pneumonia, and specific cancers: breast, lymphoma, prostate, and testicular, among other.

The guidelines establish a maximum timeline for the diagnosis, treatment, and follow-up to achieve timely care administration. For instance, in the case of time-dependent diseases such as Acute Myocardial Infarction (AMI), there were no standardized procedures before the GES program. Therefore, once the intervention started, depending on the specific case and healthcare facility, the program covered the following: i) for diagnosis, it covers electrocardiograms and specific blood tests to estimate cell death; ii) for treatment, depending on the healthcare facility, it

mandates an angioplasty in less than 90-120 minutes at high-complexity facilities or a thrombolysis within the first 30 minutes at low-complex facilities. Despite timely diagnoses and treatment being essential for the prognosis and mortality rate of this pathology before the reform, procedures largely differed between public and private hospitals, particularly between metropolitan and non-metropolitan areas without highly complex facilities. In addition, the GES program certifies quality through registered and certified health providers and ensures financial security through limits to contributions, payments, and co-payments contingent on users' income. In most cases, once the diagnosis is verified by a public or private health provider, patients' are assigned for treatment in a specific network. People cannot choose where to get care; otherwise, they lose the benefit. Depending on the health-related problem, people may have access to free prescriptions.

When initially conceived, the reform was intended to cover 56 health-related problems simultaneously. However, it was implemented gradually to test its performance and provide the system with resources for the new national standards established in the clinical guidelines (Paraje and Infante). It started with a small pilot in August 2002, covering terminal chronic kidney diseases, all childhood cancers, and congenital heart disease. Then, in 2003, cervicouterine and terminal cancers (palliative care) were added. Finally, in 2004, the reform started as a formal pilot for publicly insured seeking care in public hospitals, representing 73% of the population (MINSAL). This initial expansion covers 17 new priority conditions, including high-prevalence diagnoses amenable to mortality-averting healthcare treatment, such as heart attacks, hypertension, and diabetes. Subsequent developments in 2005, 2006, 2007, 2010, 2013, and 2019 brought the total to 85 covered conditions of varying prevalence and amenability to care.

It is essential to note that the reform also targeted specific age groups for some diseases. For instance, childhood cancers cover all types of cancer for people younger than 15. On the other hand, later expansions increased age-group coverage only. For instance, bronchial asthma was covered by the 2006 expansions for people below 15, but in 2010 coverage expanded for those above 15. Finally, there are diseases expanding only for a specific age group; cholecystectomy, a standard treatment of symptomatic gallstones and other gallbladder conditions, is covered only for people between 15-39. Detailed tables with each covered health-related problem and age group can be found in Appendix Tables A.1 through A.4.

1.3 Hypotheses

This research aims to answer the following questions: (1) Does the provision of targeted healthcare reforms that guarantee access and coverage for specific conditions reduce mortality? (2) Does targeted health care reduces mortality disparities across the socioeconomic spectrum? (3) Does guaranteed access: increase utilization, and reduce socioeconomic disparities in treatment to care?

The hypotheses I plan to test are the following: (1) the reform will reduce mortality; the effect will be strongest for: (2A) lower and middle-income groups, and increase access through surgeries (2B) in those lower and middle-income groups. In addition, there will be a: (3A) a larger increase in surgeries for health-related problems covered by the GES reform in the lower and middle-income geographic areas, and (3B) also for those insured in the public system.

These hypotheses are based on the following assumptions: (1) The GES reform will increase access to effective diagnosis and treatment for the health problems covered by the reform. (2) Lower and middle-income individuals with lower baseline access to care are more likely to have unmet health needs that the GES reform can address. (3) Increased access to care under the GES reform will lead to increased utilization, efficiency, and equity of care for the health problems the reform covers.

To provide a solid foundation for the hypotheses to be tested, it is important to establish a conceptual framework explaining the relationships between healthcare access and health outcomes. The Andersen model (Andersen, Davidson, and Baumeister) provides a useful framework to accomplish this task, as it considers a broad range of factors that can affect healthcare access, including insurance coverage policies, health organization and provider-related factors, and community characteristics.

The model suggests that the contextual elements can be divided into three categories that are similar to the individual characteristics determining access: existing, enabling, and need conditions. Existing conditions refer to factors that predispose individuals to use or not use healthcare services, such as demographics or social norms. Enabling conditions are those that facilitate or impede the use of services, such as the availability of transportation or the accessibility of healthcare facilities. Finally, need conditions refer to individuals or healthcare providers recognized as requiring medical treatment, such as symptoms of a disease or injury.

The Andersen model also identifies six dimensions of access to care that can be used to evaluate the intended improvements of healthcare policies: potential, realized, equitable, inequitable, effective, and efficient access. The GES reform aims to bridge the gap between potential and effective access to healthcare by providing guaranteed access to a list of health-related problems for the entire population. This

should ensure that individuals receive timely and effective diagnosis and treatment for their healthcare needs.

Figure A.1 illustrates the conceptual framework for the GES reform, which relates individual and contextual characteristics with health behaviors and the pathway to health and care, resulting in relevant health outcomes. By adopting this framework, the hypotheses can be formulated and tested in a way that accounts for the complex interplay between healthcare access, individual characteristics, and relevant health outcomes.

1.4 Mortality and In-Hospital Data

The primary mortality dataset is an individual-level death registry coming from the death certificates. This dataset provides us with each individual's cause of death, year of birth, sex, and place of residence. It comprises every death in the country between 1997-2017, almost 2 million records. The in-hospital data contains patient-level records of discharges from the entire health system between 2001 and 2017. This corresponds to almost 28 million records of patients who stay at least one night in a healthcare facility. It includes the patient's discharge diagnosis and demographics such as year of birth, sex, and place of residence. It also contains information on surgeries performed, whether the patient was dead or alive when discharged, the type of insurance coverage, and the type of healthcare facility (e.g., whether public or private) where they received treatment and/or passed away.

Both datasets resulted from a joint effort between the National Statistics Office, the Vital Records Office, and the Statistics Department of the Ministry of Health. The primary goal of these agencies is to classify each cause of death and patient discharge diagnosis according to the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10), the WHO's medical classification list containing codes for diseases, signs, symptoms, abnormal findings, complaints, social circumstances, and external causes of injury or diseases. Key to the empirical strategy is that the detailed clinical guidelines established during the reform are defined on a comprehensive list that includes the ICD-10 codes and the age coverage. The list is constantly updated and is publicly available from the Statistics Department of the Ministry of Health.

Even though these datasets are considered to have the highest standards, for instance, high quality on ICD10 classification (Mikkelsen et al.), there are limitations that prevent us from performing consistent analyses between them. First, in-hospital records are only available starting in 2001; then, we cannot compare earlier periods of in-hospital mortality with all mortality. Second, the type of insurance and hospital

provider, whether public or private, is only available on the in-Hospital records, implying that we can only conclude about the socioeconomic disparities in those who died in hospitals. Therefore, we decided to start the analyses in 2001, which was the first year of the in-hospital datasets.

1.5 Sample Construction and Descriptive Statistics

To construct the analysis sample, we first identify all diseases that result in deaths. For that purpose, we keep ICD-10 codes that match all death records and in-hospital deaths by patient id, which represent 95% of deaths between 2001 and 2010. We then combined individual deaths and discharge records and constructed counts of deaths, in-hospital deaths, and surgeries by the ICD-10 diseases and 22 age groups (defined as 19 five-year age groups and three ad-hoc groups for newborns, ages 1 to 4, and open-ended interval for deaths above 100). We then classify each resulting cell of ICD-10 and age group into covered and non-covered using the comprehensive list of ICD-10 and ages covered by the GES expansions between 2004 and 2007. For heterogeneity analysis, we also classify the cells from conditions that are amenable to health care following Nolte and McKee and Sommers, Long, and Baicker; see Appendix Table A.5 for a detailed list of the ICD-10 codes included.

We removed diseases included in the pilot program that happened between 2002-2003 from the sample because it was not clear how these conditions were chosen, and we only have data starting in 2001.[2] We also decided not to consider diseases included in the second wave of expansions (2010, 2013, and 2019) as controls in the study. The main reason for this decision was that the 2010 and 2013 groups of diseases covered were piloted before the program formally expanded, which can introduce bias to the estimates. Data limitations also prevent us from studying diseases included in the 2019 expansion because we only have data until 2017.[3] Among diagnoses covered

[2]This group represents 15.8% of deaths in the study period, and 69% of these were terminal cancers. Childhood cancers and congenital heart diseases were only covered for people below 15 years, while terminal cancer coverage focused on pain treatment not intended to avoid death. Additional specific cancers started to be covered later, such as colon, ovarian, and bladder in 2013, and lung, thyroid, kidney, and myelomas in 2019.

[3]Diseases included in 2019 incorporate four cancers that were covered during the 2002-2003 pilot before its specific coverage started (these were treated under cancer's palliative care). Additionally, Alzheimer's coverage started in 2019, but disease classification before 2012 is noisy and is associated only with three causes of death compared to the 15 listed in 2019. Together, these groups of deaths represented 15%.

within the time frame, 16 did not have deaths during the study period.[4] As we mentioned in the last paragraph in subsection 1.2, for some diseases, later expansions increased age-group coverage only. Therefore, we have an unbalanced panel because later expansions are not part of the study. For example, in the sample, we only study age groups below 15 for bronchial asthma because coverage was expanded to include those above 15 in the 2010 expansion, which is not part of the expansions studied. Likewise, there are diseases (ICD-10 codes) in both covered and uncovered groups because their coverage was only for a specific age group. For a detailed number of diseases covered and cells, see Appendix Table A.6.

All in all, we end up with a panel of cells with counts by age group and ICD-10 codes for 35 health-related problems covered by the reform during the 2004-2007 expansions. Almost 60% of deaths in the sample are concentrated among diseases of the circulatory, respiratory, and digestive systems, while neoplasms and injuries account for an additional 20% (for details, see Table A.7). Table A.8 reinforces the targeted nature of the reform by showing that all expansions combined targeted almost 50% of deaths in the period in an evenly distributed fashion (between 10-15% for each expansion). Finally, Table A.9 presents descriptive statistics regarding the age structure of the sample. We see that almost 75% of deaths occurred between the ages of 50 and 89. We also see the usual pattern of increasing deaths with age, peaking in the 80-84 age group and then decreasing. We also see that the reform covers around 50% of the deaths within each age group. For the 2007 distribution, there is an interesting pattern. The number of deaths decreased with age, which aligns with the fact that most of these deaths are related to polytraumatized health problems.

1.6 Discussion

The need for additional evidence surrounding the impact of health reforms on mortality and other health outcomes has been increasingly recognized in recent literature, and this study addresses an important gap in the current research. While most studies have focused on expanding coverage to the uninsured population, less is known about the effects of guaranteeing timely coverage to an already insured population, which is the focus of this study.

[4]These diseases correspond to scoliosis, cataracts, refractive impairment, strabismus, oral health for children, diabetic retinopathy, detached retina, depression, orthotics for older adults (canes, wheelchairs, others), dental emergencies, tooth loss in older adults, traumatic brain injury, eye trauma, delivery care with analgesia, major burns, hypoacusis.

To evaluate the impact of this particular reform on health outcomes, we use a comprehensive dataset that includes individual-level deaths and inpatient records. This allows us to assess the overall causal impact of the reform on the population, rather than studying specific diseases or groups of patients.

The reform under study was enacted between 2002 and 2004, and it established regulations and specific rules prioritizing the treatment of 56 health-related problems amenable to healthcare (heart attacks, ischemic stroke, hypertension, diabetes, pneumonia, and specific cancers: breast, lymphoma, prostate, and testicular, among others). The eligibility for treatment only depended on patients' diagnosis and age and was independent of their type of insurance, and the reform established specific and mandatory guidelines for providers (Missoni and Solimano). When a patient's medical diagnosis is confirmed, they are assigned to a specific network (either public or private) to initiate treatment in accordance with the established guidelines. However, given budget constraints, the diseases included in the GES program were covered in a staggered fashion.

To implement a rigorous research design, we leverage the timing of the program's coverage expansions to conduct a difference-in-differences analysis. By comparing the outcomes of interest before and after the staggered implementation of the GES program, we can estimate the causal impact of the reform on health outcomes. This approach allows us to provide valuable insights into the effectiveness of the reform and its impact on population health.

Chapter 2

The Impact of a Health Reform on Mortality: Evidence from the Explicit Health Guarantees in Chile

2.1 Introduction

The study aims to establish a causal research design that allows for credible conclusions regarding the impact of health reforms on mortality rates. In contrast to previous literature that primarily relied on geographic variation, such as the U.S Affordable Care Act, in this study, the variation came from the diseases covered under the nationwide GES reform. As a result, computing death rates with different denominators for the covered and non-covered groups of diseases was not feasible. Therefore, we leverage the staggered implementation of the covered group of diseases, allowing for a comparison of covered and non-covered disease age cells. A staggered difference in differences was used to estimate the effect of the reform, and a Poisson model was employed due to the absence of cell-specific denominators.

The study's main finding is that the GES reform resulted in a 4.4% reduction in deaths, with a larger impact observed in diseases amenable to health care, which decreased deaths by 7.1%. The study also found a decrease of 6.9% in in-hospital deaths and an increase of 16% in surgeries, mainly driven by inpatients at public hospitals. This suggests that the policy narrowed socioeconomic disparities in access to care. Furthermore, an event study validated the parallel (relative) trends assumption and indicated that the impact of the reform persisted until the end of

the analysis period. Several validation exercises demonstrated that the result was not driven by any specific disease, was similar when considering only treated (ever covered) cells for identification, and was robust to recent developments that allow for treatment effect heterogeneity over time or across groups (Wooldridge).

The study also examined the mortality effects of a subset of diseases that are considered to be "more health care-amenable "Nolte and McKee, as suggested by previous research (Sommers, Long, and Baicker; Sommers; Miller, Johnson, and Wherry). The findings showed that mortality fell by 7.1% for these diseases, indicating that they were more responsive to better access to medical care. However, less amenable diseases only saw a decrease of 2.8%, indicating that the reform's effect was less pronounced in this group.

2.2 Empirical Strategy

The reform's design- aimed at guaranteeing the early and adequate diagnoses and treatment of high-cost and high-mortality diseases- allows us to implement a staggered difference-in-differences research design. In particular, we leverage the timing of coverage among different disease-age cells to study changes in cell-level outcomes (e.g., deaths) before and after reform coverage. Because we only observe deaths and not how many individuals suffered from each disease, we do not have denominators for constructing disease-specific death rates. In the absence of denominators, the outcomes of interest will be yearly counts within disease-age cells, e.g., the number of deaths or surgeries associated with ischemic strokes among people between 35 and 39 years old in a given year. Thus, we will fit Poisson models for counts using a log link(Wooldridge; Wooldridge). The general specification that we estimate is given by:

$$y_{dt} = \exp(\alpha_d + \gamma_t + \beta GES_{dt} + \epsilon_{dt}), \tag{2.1}$$

where y_{dt} is the count of our outcome of interest for a cell d (disease-age) in period t. GES_{dt} is an indicator that equals one from the first time a disease-age cell is covered by GES and onward, i.e., the treatment is an absorbing state. α_d represents cells' fixed effects that control for unobservables specific to the disease-age cell and γ_t are time-fixed effects accounting for unobservable time shocks. Finally, ϵ_{dt} is an error term clustered at the level of treatment (disease-age cell). In this model, identification of the *causal* effect of the GES reform is predicated upon the assumption that—conditional on time-invariant disease-age cell indicators and year aggregate shocks—there are no unobserved factors that correlated with both the timing of coverage and other determinants of health outcomes.

Our parameter of interest is the rate ratio (RR) identified through the Poisson model. For two time period, the RR is defined as:

$$\exp(\beta) = RR = \frac{\frac{E[Y_{d2}|GES=1]}{E[Y_{d1}|GES=1]}}{\frac{E[Y_{d2}|GES=0]}{E[Y_{d1}|GES=0]}}, \tag{2.2}$$

where Y_{dt} is the count of deaths for diseases-age cell d in period t, and GES equals one when a cell is covered by GES. A rate ratio sometimes called an incidence density ratio or incidence rate ratio is the relative difference measure used to compare the incidence rates of events occurring at any given point in time (Dicker et al.). Therefore, the interpretation of the value of a rate ratio is similar to that of the risk ratio. That is, a rate ratio of 1 indicates equal rates in the two groups, a rate ratio greater than 1 indicates an increased risk for the treated group ($GES = 1$), while a rate ratio less than 1 indicates a decreased risk for the treated group ($GES = 1$). To ease the exposition, we present our results as percent changes by subtracting 1 from the RR, i.e, $exp(\beta) - 1$. Thus, if the GES reform led to a relative decrease in the number of deaths among the covered diseases, we would expect our coefficient to be negative.

In our Poisson setting, the identification assumption, commonly known as "parallel trends", requires that the death ratios between the group of diseases (covered and not covered) would have been constant over time in the absence of the reform. For this reason, this assumption is also referred to as "parallel relative trends". In other words, the implicit identifying assumptions are: (1) fixed characteristics within diseases (no change over time) and (2) time trends for change in deaths are the same for covered and not covered diseases. To assess the plausibility of this parallel (relative) trends assumption, we examine the dynamic effects of GES using event studies around the time a new disease is covered. The time periods and coverage expansions in our analysis allow us to have a 3-year moving window around each expansion. We will use a leads-and-lags model in event time, with the first expansion year set to zero. Specifically, we estimate the following equation:

$$y_{dt} = exp\left(\alpha_d + \gamma_t + \sum_{k=\underline{C}}^{-2} \beta_k D_{dt}^k + \sum_{k=0}^{\overline{C}} \beta_k D_{dt}^k + \epsilon_{dt}\right), \tag{2.3}$$

where $D_{dt}^k = 1[t = GES_d + k]$, and GES_d is the timing of inclusion of disease-age group d. D_{dt}^k is a dummy variable indicating that disease-age cell d was included in GES k periods ago (or will be included k periods ahead for negative values of k). We normalize the coefficients such that $\beta_{k=-1} = 0$—that is, treatment is re-coded in

event time relative to the year in which each disease-age group was included in the GES expansions. Therefore, the β_k coefficients can be interpreted as the effect of GES on y_{dt} for each k period, relative to the date before the inclusion of d in GES.

2.3 Main Results

We begin by exploring the mortality impact of the reform using raw data. In Figure 2.1 we plot the change in the number of deaths in covered diseases against the change in the number of deaths in never-covered diseases for each expansion. Panel (a) shows that change in deaths covered by the 2004 expansion decreased compared to the never-covered group. Panel (b) shows that deaths of diseases covered in 2005 also decreased proportionally more than deaths of non-covered diseases a year after the expansion, although the difference between covered and non-covered is smaller in this case. Panel (c) shows the evolution of deaths for diseases whose coverage was included in 2006. In this case, there is also a decline compared with the never covered. Finally, panel (d) shows the differential trends between diseases included in the 2007 expansion and those never covered. Again, all deaths increased, but those covered by the 2007 expansion increased far less. Importantly, the overall increase in deaths shown in Figure 2.1 is mainly driven by an aging population. Appendix Figure A.2 shows standardized cause-specific death rates accounting for population growth and population aging by weighting yearly death rates with the age distribution in 2001.[1] It shows that adjusted death rates are actually *decreasing* throughout the analysis window. For the interested reader, Appendix Figure A.3 presents population pyramids showing how the age distribution has changed in Chile during the last 3 decades.

Even though previous evidence is purely descriptive, it suggests that the reform had an effect on mortality. To formally study this hypothesis—and to quantify the impact of the reform—we now present the results obtained from our difference-in-differences research design. Table 2.1 presents the results obtained from estimating equation (2.1). Our main result is presented in Column (1) and considers the count of all deaths as the dependent variable.[2] Consistent with the preliminary evidence,

[1] We proceed in the following way: i) we calculate crude death rates for age x as the number of deaths for each group of GES disease-population of age X divided by the population of age x, where x stands for 5-year age groups (i.e., 0, 1-4 years, 5-9 years,..., 85-99 years, and greater than 100 years); ii) we multiply the ratio obtained in step i) by the population share in 2001; and finally, iii) we sum across all the weighted age-specific shares obtained in step ii).

[2] Appendix Table A.10 shows that we obtain similar results if we estimate a negative binomial regression or a linear regression using the log of deaths+1 and the inverse hyperbolic sine as ad-hoc transformations to deal with the zero count cells.

we find a statistically significant impact of the reform on mortality: the average risk of dying from diseases going from uncovered to covered decreases by 4.4% after the reform began. This effect is a weighted average across all disease-age cells and expansions, which allows us to compute the number of deaths averted due to the reform. In our estimation sample, the covered group had 29,331 deaths in the pre-expansion period. Therefore, there would have been 1,290 deaths saved once they went from uncovered to covered. Considering 53,950 deaths a year before the coverage starts lives saved *due* to the reform would represent 2.4% of the deaths in the sample.

To study the dynamics of the impact on mortality, Figure 2.2 presents the event-study estimates obtained from equation (2.3) using the count of all deaths as the dependent variable.[3] The horizontal axis shows the years relative to the expansion, with event time denoting the first year of the expansion. We omit event time -1 so that all estimates are relative to the year before the expansion. Point estimates of leads and lags are plotted along with their 95% confidence intervals. This figure shows that pre-period estimates are not statistically different from zero, a result in line with our parallel (relative) trends assumption.[4] Moreover, the figure shows a decrease in deaths in the treated diseases immediately following the expansions. Indeed, the magnitude of the point estimates grows over the post-expansion periods so that, four years post-treatment, deaths have declined by 7% ($p \leq 0.001$) relative to the year before the expansion.

Recent literature on two-way fixed effects estimators have shown that estimates from this model can differ from the group's ATT in the presence of treatment effect heterogeneity (De Chaisemartin and d'Haultfoeuille; Callaway and Sant'Anna; Sun and Abraham). To address this concern, we follow recent work by Wooldridge and Wooldridge, whose method is robust even if the treatment effects are heterogeneous over time or across groups, and which can be adapted to non-linear settings such as ours. In particular, we run a regression with cell and year-fixed effects as before, but now we saturate it with the interaction of all treatment cohorts (GES expansions) and event time dummies. Intuitively, this approach assesses the impact of the GES expansions jointly but allows each expansion to have its own dynamic, using never treated cells as controls. To present our results, we recover estimates and confidence intervals from the pooled Poisson regression and plot them separately for each expansion. Figure A.5 in the appendix presents these results. Reassuringly, we find evidence consistent with our main findings across all expansions.

[3]Figure A.4 finds similar effects between Poisson and Negative Binomial

[4]Table A.11 complements this validation exercise by showing pre-treatment characteristics coming from the death records of covered and non-covered cells. Overall, we observe balance along an array of cell characteristics including type of insurance, education, gender, marital status, and geographical location.

We also check the robustness of our results to estimating equation (2.1) in a sample of *ever covered* cells. In this case, identification of the impact of the reform only leverages variation in the timing of adoption among covered diseases. We find that among "ever covered" cells, expansions led to a 4% decrease in mortality (see Appendix Table A.12, column 1). This is very similar to the main estimate from our staggered difference-in-differences.[5] Finally, to assess whether our results are driven by a particular set of diseases, we estimate our main difference-in-differences model, given by equation (2.1), but removing one treatment cell from the sample each time. Figure 2.3 shows the results obtained from this exercise. Reassuringly, in all cases we find negative and statistically significant impacts of the reform on mortality. Moreover, most point estimates are around the average effect of a 4.4% mortality decrease, with the exception of the estimates obtained after the removal of Ischemic stroke from the set of treated cells, which leads to a smaller impact of the reform on mortality, suggesting that this disease accounts for a non-trivial part of the overall treatment effect.

Having stated the impact of the reform on overall mortality, we now turn to other outcomes. In light of recent research suggesting that some diseases may be more responsive to access to medical care (Sommers, Long, and Baicker; Borgschulte and Vogler; Miller, Johnson, and Wherry), we begin by studying the impact of the reform on two subsets of diseases: those considered to be more "health care–amenable" and those that are less. For this analysis, we use the classification described in section 1.5.[6] Columns (2) and (3) of Table 2.1 shows the estimates obtained from estimating equation (2.1) on Amenable and Less-Amenable death counts. For both outcomes, the effect is negative. Nonetheless, the magnitudes of the effects are substantially different, with the effect on more amenable causes of death more than doubling the effect on the rest of the causes. According to our estimates, deaths more amenable to health care decreased by 7.1% as a consequence of the reform. This is a large effect on a relatively smaller set of deaths, a fact that leads us to conclude that a large part of the effect on mortality is driven by the targeting of causes of death that are more amenable to health care.

To complement our previous result, in Figure 2.4 we present event study evidence on the set of more amenable and less amenable diseases. Panels (a) and (b) display the plots for the set of diseases more amenable and less amenable to health care, respectively. For more amenable diseases, we see that the figure is similar to the

[5] In the appendix, we also present estimates on the impact of the reform that consider different samples of diseases included in different expansions and that only use never-treated cells as controls. Columns 2-5 of Appendix Table A.12 and Figure A.6 present these results.

[6] Our classification encompasses both the work by Nolte and McKee and by Sommers, Long, and Baicker. See Appendix Table A.5 for details.

one considering all deaths but is larger in magnitude. For the "less amenable" set of deaths, there is also a negative but much smaller effect. Reassuringly, none of these event studies suggest evidence of the existence of pre-trends. All in all, this analysis shows that although the reform targeted deaths more amenable to health care, it also had an impact, albeit smaller, on the deaths "less amenable" to care. In Appendix Table A.13 we perform a robustness check and repeat this analysis under alternative classifications of deaths, including Tobias and Yeh, Nolte and McKee, and the one used by the European Union. We find similar results in all these cases.

Finally, we leverage inpatient records to complement previous results. In columns (4) and (5) of Table 2.1, we present the estimates obtained from estimating equation 2.1 using in-hospital deaths and surgeries as dependent variables. We find that in-hospital deaths decreased by 6.9% as a consequence of the reform. This effect, larger than the mortality impact on the population as a whole, is consistent with the fact that in-hospital deaths come from a sample of patients for whom we know medical care was provided and who spent at least one night, i.e., they show up in a hospital's discharge records. Panel (a) of Figure 2.5 shows the dynamic impact of the reform on in-hospital deaths. We observe that differences between treatment and control groups were almost nonexistent before the treatment. However, exactly after the coverage expansion, the number of in-hospital deaths for covered diseases decreased significantly.

Regarding surgeries, our estimates reveal that the reform increased them by 16% (column 5 of Table 2.1). This is a significant increase consistent with the reform's goal of prioritizing the treatment of covered diseases. Turning to the dynamic effects, Panel (b) of Figure 2.5 confirms that surgeries increased in the wake of the expansions. The estimates indicate that surgeries had increased by 4% immediately after the expansions and grew over the post-expansion period. Four years after treatment, surgeries had increased by almost 30%, although our estimate for the last period is significantly noisier than the previous ones.

2.4 Discussion

The main result shows a statistically significant impact of the reform on mortality: the average risk of dying from diseases going from uncovered to covered decreases by 4.4% after the reform began. This effect is a weighted average across all disease-age cells and expansions, which allows us to compute the number of deaths averted due to the reform. Based on this number, it is estimated that 2.4% of the total number of deaths in 2003 were saved due to the reform, which is equivalent to an increase in life expectancy large enough to bring mortality conditions forward to those of 2005

when life expectancy was 77.78 years (See Appendix B).

The event-study estimates also support this finding, showing a decline in deaths in treated diseases immediately following the expansions. The study's design, including the use of difference-in-differences and event-study methods, helps to account for potential confounding factors that could affect the results. Turning to inpatient outcomes, the reform decreased in-hospital mortality by 6.9%. This larger impact is consistent with individuals in these records seeking and receiving medical attention. Additionally, the reform's guidelines for the timely treatment of diseases likely led to an increase in hospital procedures, as evidenced by a 16% increase in surgeries after the reform. Both of these effects are significant and stable within the time window of our analysis. The study's findings provide valuable insights into the effects of healthcare reform and can inform future policies aimed at improving healthcare outcomes.

Finally, a natural concern would be the potential substitution effect of the reform due to a potential shift in healthcare resources from uncovered to covered diseases. The Chilean government attempted to address this issue through a tax reform proposed by the president in 2003, which aimed to fund key social needs, including the implementation of The Explicit Health Guarantee Reform known as GES.[7] The government funded the GES program *de jure* by increasing the value-added tax by one percentage point, which brought in an additional 1.8% of the GDP in revenue after one year of implementation. [8] It is unclear though, how much excess capacity there was in the healthcare system, and expanding hospital and surgical capacity and personnel may take time, so this is a potential concern.

To help assess whether the reform improved access to care in covered diagnoses at the expense of non-covered ones, we analyze disease-specific time trends from inpatient records (since data on public spending by ICD-10 is unavailable in Chile). Using an age-adjusted rate, Figure 2.6 compares coverage rates for diseases or health conditions between different populations across years while controlling for differences in age distributions. Panel a) shows that discharges did not decrease for the non-covered group of diseases after the reform, so these raw patterns are not consistent with substitution. Instead, discharges for non-covered diseases increased fairly dramatically – which raises different concerns about the size of idiosyncratic shocks that could be shaping these patterns. In Panel b), we see that surgeries for the non-covered behave similarly to the rest of the group of diseases in the pre-reform years 2001-2003, though there was a relative decrease just before the reforms in 2004. So

[7]The 19.888 bill entered the Chilean Congress in June 2003, and approved in August 2003

[8]Between 2000 and 2010, the proportion of the GDP allocated to healthcare spending grew from 2.8% to 3.5%, with the most significant increase occurring between 2007 and 2008, rising from 2.7% to 3.1% (Government of Chile).

again, these raw data do not show substantial decreases in non-covered surgeries just after the reforms, but other idiosyncratic movements raise potential concerns.

To further explore these potential substitutions or idiosyncratic shock concerns, we use WHO mortality data from other Latin American countries over this time period. We include those countries with high-quality mortality data: Mexico, Venezuela, Paraguay, Brazil, Costa Rica, Nicaragua, Panama, and Colombia.[9] For each country, we can construct a panel of cells like the ones used in our manuscript and classify them as covered and non-covered using the ICD-10, age categories, and the timing of the Chilean GES reform.

We begin by focusing on the mortality trends in never covered diseases. In Figure 2.7, we plot the time trends of uncovered diseases for different countries. Panels (a) and (b) use the raw data. Panel (a) show that deaths from uncovered diseases did not increase disproportionately in Chile compared to similar countries relative to the year before the reform started. Likewise, Panel (b) show that the yearly growth in deaths for uncovered diseases did not increase/decrease disproportionately in Chile, , but fluctuated closely around zero as in most countries. In panel (c), we extend this analysis and construct a synthetic control for Chile. Specifically, we use lags of the logarithm of deaths, the logarithm of cumulative deaths, and the growth of deaths before 2004 (the first year of the GES reform) to calculate weights. Reassuringly, we see that the evolution of deaths in Chile matches its counterfactual very closely up to 2004, with no clear signs of divergence afterward.

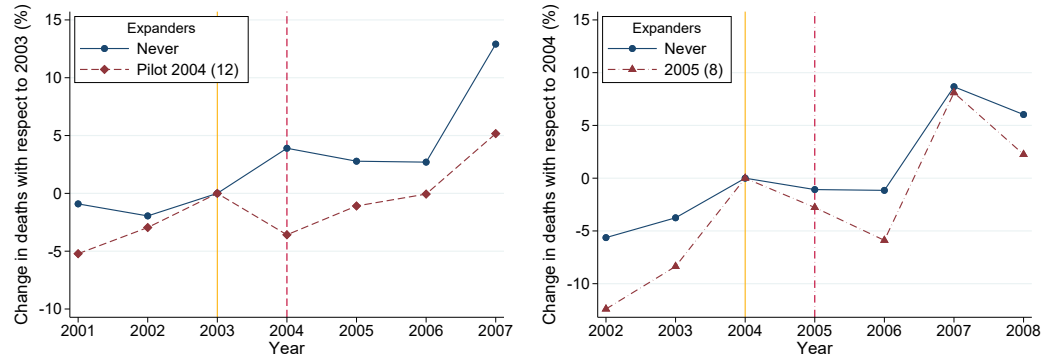
To further address the "substitution" concern and to tackle concerns related to shocks idiosyncratic to specific diseases, in Table 2.2, we leverage the WHO data to perform several analyses. First, as a data check, we replicate our main result using the WHO data for Chile. In this case, we consider covered and non-covered diagnoses, and—as shown by column (1)—we find a similar impact of the reform (-3.6%).[10] In column (2), we also focus on Chile but now considering exclusively ever-covered cells (i.e., removing never covered cells from the control group). Reassuringly, the magnitude of the treatment effect when we leverage only the timing of coverage is -3.9%, a figure similar to that previously reported by us. In column (3), we perform a falsification analysis for which we consider covered cells in other countries and estimate our main model—specification (2) in the manuscript—now

[9]Data is publicly available in the WHO webpage.

[10]The difference between the Chilean-source data and the WHO database is that the latter has an open-ended age interval of 95 years and above while the former has an open-ended interval of 100 years and above. Moreover, the WHO database classifies deaths under chapter XIX (that range from S00 to T98), titled "Injury, poisoning and certain other consequences of external causes", based on the *underlying* cause of death. In contrast, we considered them as the leading cause of death.

also interacting cell and year dummies with country-fixed effects. As expected from this placebo check, we cannot reject the null of a zero impact of the Chilean reform in other countries. In Column (4), we present the results obtained when considering *covered* cells in all countries and adding an interaction between "GES" and "Chile". This should help to isolate the identification of the reform's impact from trends in never covered diagnostics, i.e., we will use the evolution of *covered* diseases in other countries, before and after their coverage in Chile, as control. We find that the negative impact of the reform on deaths is significant in Chile but not in other countries. Finally, in column (5), we compare deaths in never covered diseases in Chile to those in other countries. For this exercise, we interact an indicator for Chile with an indicator for 2004 (when the reform started) and include year and cell fixed effects in addition to an indicator for Chile. In line with Figure 2.7, we cannot reject the null of a zero impact of the reform on never covered diseases.

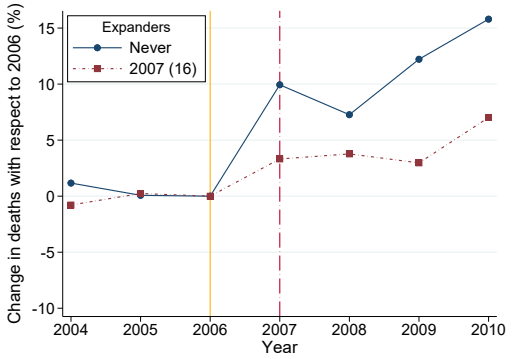
Figure 2.1: Change in deaths for each GES expansion



A. 2004 Expansion

B. 2005 Expansion

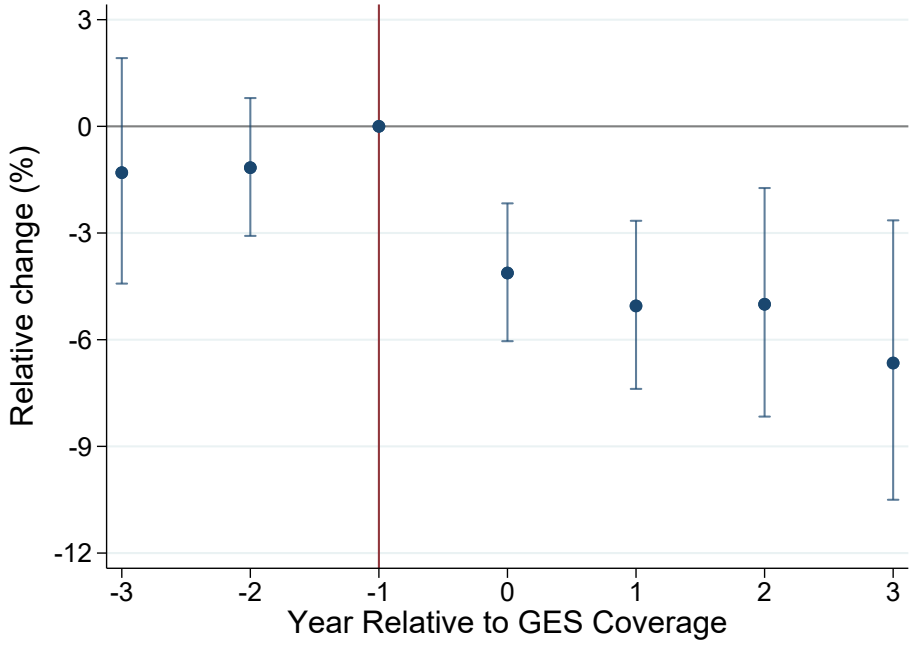
C. 2006 Expansion



D. 2007 Expansion

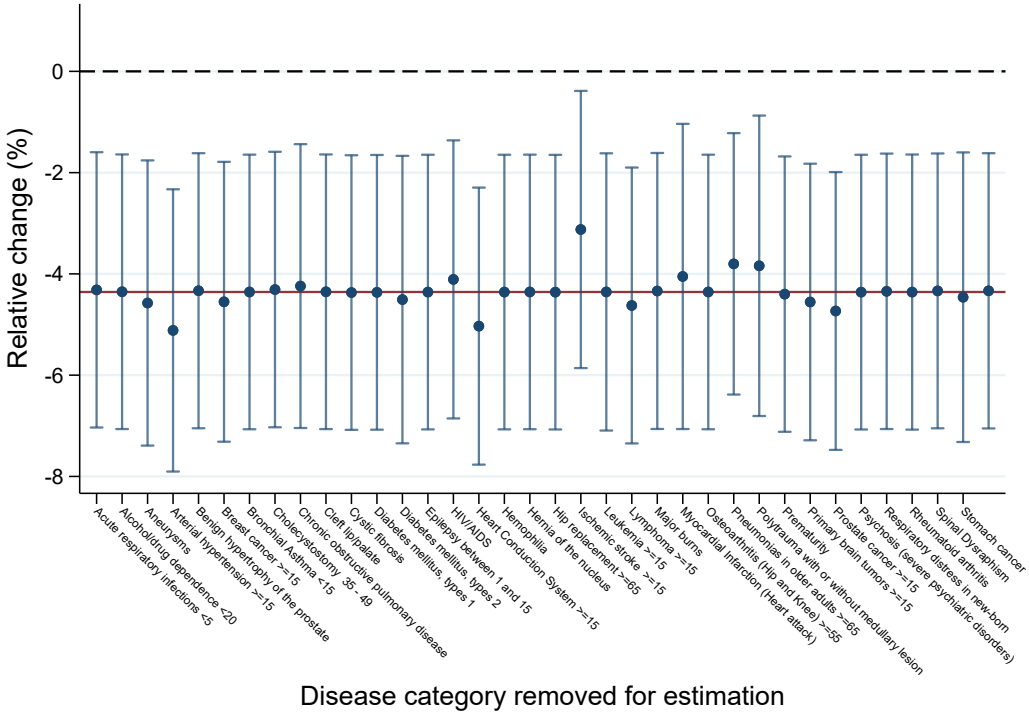
Notes: This figure shows the change in deaths for both the diseases covered by each GES expansion and the diseases never covered by the GES reform. All changes in deaths are reported in percentages and calculated with respect to the year before each expansion. The vertical solid yellow line represents one year before the expansion.

Figure 2.2: Event study: GES impact on deaths



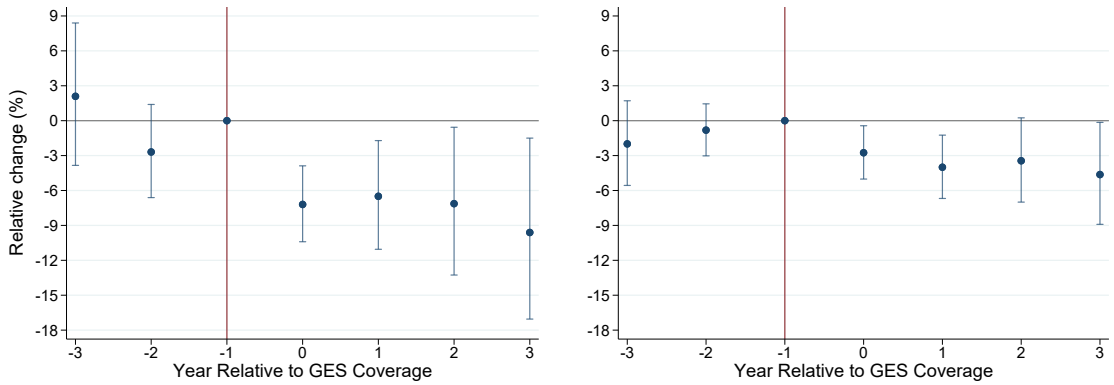
Notes: This figure shows the results obtained from estimating the dynamic difference-in-differences presented in equation (2.3) using the count of deaths as the dependent variable in a Poisson regression. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Each RR is capturing the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Figure 2.3: Sensitivity of the treatment effect to targeted diseases



Notes: This figure shows the results obtained from estimating (several times) the dynamic difference-in-differences presented in equation (2.3) using the count of deaths as the dependent variable in a Poisson regression. Each point estimate and confidence interval comes from a regression in which we remove one treatment cell at a time, as indicated per the x-axis. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Each RR is capturing the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Figure 2.4: Event study: GES impact on more and less amenable deaths

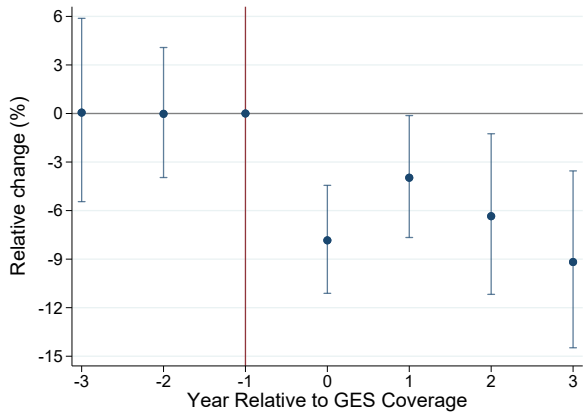


A. More amenable

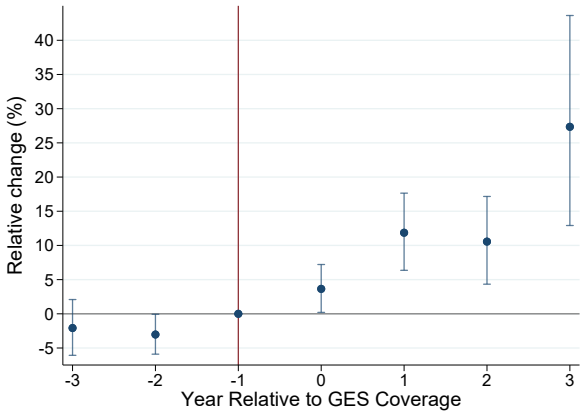
B. Less amenable

Notes: This figure shows the results obtained from estimating the dynamic difference-in-differences presented in equation (2.3) using the count of deaths as the dependent variable in a Poisson regression. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Panel (a) shows the event study for the set of deaths more amenable to health care (Nolte and McKee; Sommers, Long, and Baicker). Panel (b) shows the event study for the set of deaths less amenable to health care. less amenable deaths do not mean they cannot be impacted by health care, only that these deaths are likely to be less responsive to health care coverage than other causes. Each RR is capturing the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. For details about the Amenable classification, see Appendix Table A.5.

Figure 2.5: Event Study: GES impact on in-hospital outcomes



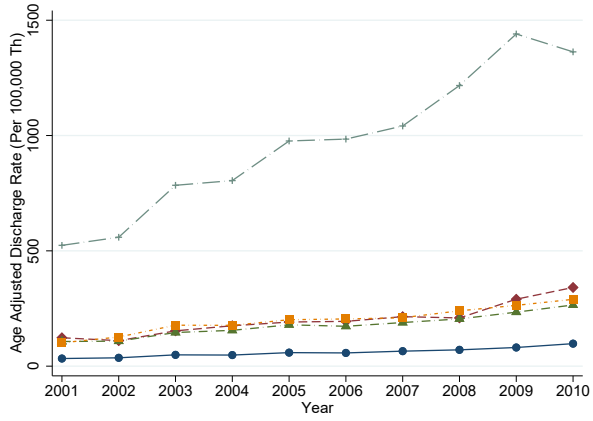
A. Deaths



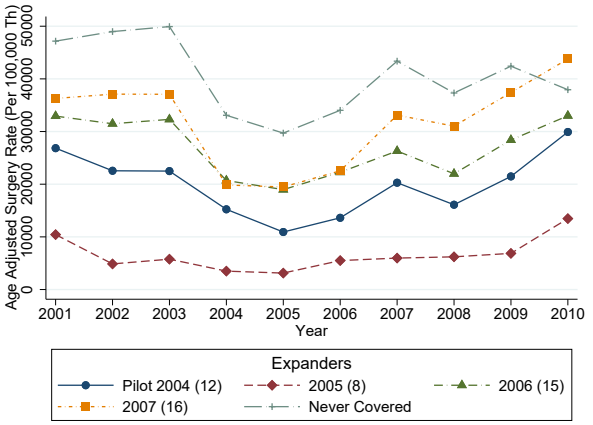
B. Surgeries

Notes: These figures show the results obtained from estimating the dynamic difference-in-differences presented in equation (2.3) using the count of in-hospital deaths and in-hospital surgeries as dependent variables in Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Panel (a) shows the event study for the count of in-hospital deaths. Panel (b) shows the event study for the count of surgeries. Each RR captures the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Figure 2.6: Age Adjusted Surgery and Discharge Rates by wave of Expansion



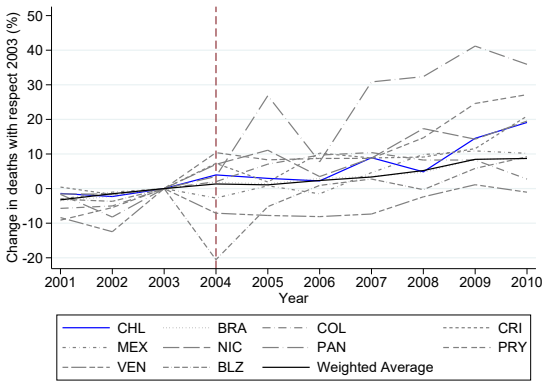
A. Discharges



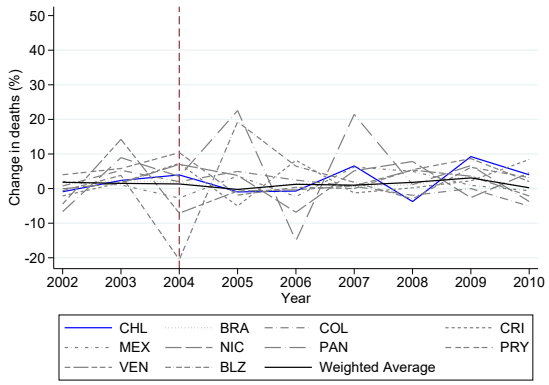
B. Surgeries

Notes: This figure shows Discharge and Surgeries rates for each of the waves of expansion adjusted by age. Age adjustment is made to eliminate the confounding effect of age, which can distort the true differences in disease rates across time. This is particularly important when comparing disease rates between populations with different age structures. To calculate an age-adjusted rate, the observed number of cases in each population age group is standardized to the 2001 population as the standard age distribution. The standardized rates are then combined to generate an overall age-adjusted rate, which provides a summary measure of disease incidence that is comparable across different populations with varying age structures.

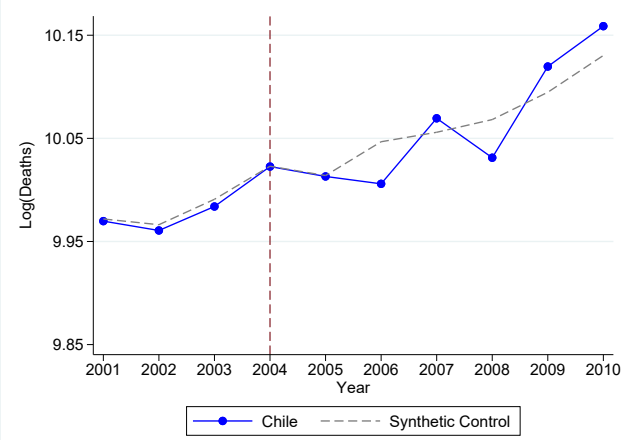
Figure 2.7: Change in deaths for never-covered diseases in Chile and Latin America



A. Change in deaths w.r 2003



B. Change in deaths w.r previous year



C. Synthetic Control

Notes: This figure shows the time trends of deaths in uncovered diseases for different countries. Panels (a) and (b) report the percentage changes in deaths. The weighted average line shows the sum of countries' deaths using their contribution to total deaths (across countries) as weights. Panel (c) shows the result from a synthetic control analysis that uses log deaths in non-covered diseases as the main outcome. The vertical dashed red line represents the year the reform coverage started in Chile. Selected countries are those with high-quality mortality data under the World Health Organization classification. See the main text for details.

Table 2.1: GES impact on health outcomes

	Deaths			In-Hospital	
	All	*More* Amenable	*Less* Amenable	Deaths	Surgeries
	(1)	(2)	(3)	(4)	(5)
GES	-0.044***	-0.071***	-0.028*	-0.069***	0.163***
	(0.014)	(0.026)	(0.016)	(0.020)	(0.033)
# Counts of dep. var	521,300	96,966	424,334	173,263	790,512
# Counts of dep. var covered by GES (as of 2003)	29,331	7,693	21,638	7,942	14,202
Total No. disease-age cells (obs.)	99,146	18,236	80,910	81,745	107,447

Notes: This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The RRs captures the average effect for all groups of diseases after they started to be covered. Less amenable deaths do not mean they cannot be impacted by health care, only that these deaths are likely to be less responsive to health care coverage than other causes. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 2.2: GES impact on Mortality using WHO Mortality Database

	Diagnoses				
	All	Only covered			Never covered
	Chile	Chile	Other countries	All countries	All countries
	(1)	(2)	(3)	(4)	(5)
GES	-0.036**	-0.039***	-0.010	-0.010	
	(0.015)	(0.011)	(0.009)	(0.009)	
GES × Chile				-0.029**	
				(0.015)	
2004 × Chile					0.023
					(0.021)
Total No. disease-age cells (obs.)	83,390	16,520	125,678	142,198	1,045,860
Mean Dep. Var	5.504	13.97	38.49	35.64	4.857

Notes: This table shows the results from different Poisson regressions using death counts from the WHO Mortality dataset. All regressions control for disease-age cell fixed effects and year fixed effects. In addition, columns (3) and (4) use disease-age cell fixed effects, and year-fixed effects interacted with country-fixed effects. Column (1) considers data for Chile, including covered and non-covered diseases. Column (2) considers data for Chile, including only covered diseases. Columns (3), (4), and (5) also use data from other countries; columns (3) and (4) include only covered diseases while column (5) includes only non-covered diseases. All coefficients correspond to percent changes by subtracting one from the rate ratio (RR), i.e., $exp(\beta) - 1$. Standard errors are clustered at the level of treatment: disease-age in columns (1) and (2), diseases-age-country in columns (3) and (4), and disease-age-Chile in column (5). Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Chapter 3

The Heterogeneous Effects of the Explicit Health Guarantee Reform on Sociodemographics and Geographics

3.1 Introduction

In this chapter, we build upon our main analysis in Chapter 2 by conducting various sub-sample tests to examine the differential impacts of the healthcare reform across different socioeconomic, demographic, and geographic groups. Our research questions are guided by hypotheses (2) and (3) in subsection 1.3, which explore whether the targeted healthcare reform reduces mortality disparities across the socioeconomic spectrum and whether guaranteed access leads to increased utilization, improved efficiency, and reduced socioeconomic disparities in healthcare treatment.

To test the first hypothesis, we investigate whether the healthcare reform has a stronger effect on lower and middle-income groups with limited baseline access to healthcare. We anticipate that these groups will benefit the most from the reform as they have historically experienced the highest mortality due to inadequate healthcare access. By analyzing this sub-sample, we can determine whether the reform effectively reduces mortality disparities across the socioeconomic spectrum.

Next, we investigate sex and age-stratified results as some diseases are only covered in specific groups of individuals. We will examine the impact of the reform on specific groups, such as females or males, and certain age groups to determine whether the reform is effectively addressing their unique healthcare needs. By ana-

lyzing this sub-sample, we can determine whether the reform is providing equitable access to healthcare across all demographic groups.

Lastly, we explore whether the healthcare reform leads to an increase in the surgery rate for health-related problems covered by the GES reform in lower and middle-income geographic areas, as well as for those insured in the public healthcare system. We predict that these groups will see the greatest improvement in access to surgical care due to the reform, as they may have had limited access to these services before the implementation of the reform. By examining this sub-sample, we can determine whether the reform improves efficiency and reduces healthcare disparities in treatment.

3.2 Socioeconomic, Demographic and Geographic Heterogeneity

We begin by exploring socioeconomic disparities. Public hospitals are the largest medical bed providers and serve the most disadvantaged populations.[1] Moreover, public providers tend to be more crowded and have longer wait times. Indeed, as of 2016, only 24% of the 348 hospitals in the country were private, but 55% of doctors worked in the private sector (Clinicas de Chile; Gonzalez et al.). Additionally, previous studies found that patients at public hospitals show a higher risk of in-hospital death (Cid Pedraza et al.). In this context: do patients seeking care at public hospitals benefit more from this reform? To answer this question, we estimate our main regression but distinguish by type of healthcare provider. Table 3.1 shows our results. Estimates show a statistically significant effect of the reform on mortality in public hospitals, which decreased by 7.3%. The corresponding estimate for private hospitals is only 2.5% and is not statistically significant.[2] We find a consistent pattern when focusing on surgeries. In public hospitals, surgeries increased by 23%, but they only increased by 0.8% at private hospitals. All in all, this analysis shows that most of the impact of the reform is concentrated in public hospitals, a finding that we interpret as evidence of the reform reducing socioeconomic disparities.

We now present stratified results between different sexes and age groups. This analysis is motivated by the fact that diseases expanded only for specific sex and age groups. While the disease-age group cells are very similar between the sexes, this is

[1] Based on discharge records, 96% of patients at public hospitals have public insurance.

[2] Appendix Table B.2 shows that this result is robust to the removal of diseases included in the pilot expansion of 2004, which exclusively targeted patients with public insurance seeking care at public hospitals.

not the case for the age groups.[3] Table 3.2 presents our results. Even though the reform targeted sex-specific diseases, we find no significant differences for sex-stratified results in terms of deaths and surgeries. However, we find important differences between age groups. Notably, and despite the fact that the increase in surgeries is similar for those between 0 and 49 and those above 80, the decrease in deaths between ages 0 and 49 was almost four times larger than the decrease in deaths among those above 80. The absence of an effect on old age mortality may be associated with the scope of the reform on deaths amenable to high-quality and timely health care, which are usually found in patients below the age of 75-79 (Mackenbach et al.; Nolan et al.).[4] It can also be related to the fact that co-morbidity increases with older age; hence, assigning a single underlying cause of death becomes more uncertain at older ages, making the classification noisier for these groups of deaths (Weber and Clerc).

Finally, we study the heterogeneous effects of the reform by geographic location. Specifically, we estimate the impact of the GES coverage expansions in each macro zone of Chile. These macro-zones aim to represent an evenly distributed population across the country.[5] In Table 3.3, we present the results obtained after estimating our main equation (2.1) in different macro-zones. Panel A, which considers deaths as the dependent variable, shows non-significant effects for the extreme zones, such as the North and Austral zones. More interestingly, we find that in the Metro area, where the capital city—Santiago—is located, the reform did not significantly affect deaths. In contrast, deaths decreased from 6.8 to 7.7 percent in the Center, Center-South, and South macro-zones. Looking at the impact on surgeries (Panel B), our results show large increases, ranging from 12% to 21%, in all but the South and Austral zones. This result could be explained by fewer resources (physicians, equipment) in the most extreme and rural south regions, in contrast to the capital city, where it was easier to access evidence-based treatment and procedures before the reform standardized them nationwide. This could also be interpreted as evidence that the reform narrowed geographical disparities with the implementation of the clinical guidelines and prioritization of specific procedures.

To enhance our previous analyses, we present Appendix Tables B.4 to B.3 and Figures B.1 to B.5, which offer a more comprehensive understanding of the extent

[3]In fact, we see that observations decrease with age because, by definition, we are grouping fewer cells for older ages.

[4]In our sample, 23% of deaths more amenable to healthcare are below 50 years old, 77% for those between 50 and 79 years old. None of the deaths after 80 years are classified as deaths more amenable to health care

[5]Most of the population is between the center and south macro zones, heavily concentrated in Santiago, the central Metropolitan area (Metro) in the country with almost 40% of the population, totaling 8 million people.

to which the healthcare reform increased access to medical procedures. Appendix Table B.3 provides insights into the distribution of deaths across different hospital types and insurance groups, along with the reform's impact on in-hospital deaths by geographic area.

Columns (2)-(3) of the table demonstrate that most of the deaths occurred in public hospitals and among publicly insured individuals, with fewer deaths in the main metropolitan area compared to the rest of the country. Column (4) shows the coefficient for in-hospital deaths by geographic area, indicating that the reform had a negative impact on individuals with healthcare access in the metropolitan area, as opposed to all deaths shown in column (1), where there was no effect.

Columns (5)-(7) display the share of people who underwent surgeries in public hospitals and were publicly insured, along with the reform's effect on surgeries. We can see that the metropolitan area had the lowest share of people receiving surgeries in public hospitals and being publicly insured, but with a positive and significant reform effect.

Together, these findings suggest that the healthcare reform has had a significant impact on reducing mortality rates and improving access to medical procedures, especially for individuals in public hospitals and those who are publicly insured. However, the reform's impact varies across geographic areas, with the metropolitan area experiencing different outcomes compared to the rest of the country. These findings highlight the need for ongoing evaluation and monitoring of the reform's impact to ensure equitable access to healthcare for all individuals, regardless of geographic location or insurance status.

In Appendix Table B.4, we present the results of deaths from Table 3.3, classified by urban and rural areas. Although most of the significant results are in urban areas, we believe this may be due to misreporting between the place of death and residence. Fewer deaths are classified as rural than in urban areas.

To visualize these results, Appendix Figure B.1 presents a Chilean choropleth map of the coefficients, similar to Table B.4. However, the death coefficients are plotted as positive values to match the impact of surgeries on the left-hand side. Thus, we can observe that the increases in surgeries are consistent with the decreases in deaths.

To provide further insights into the heterogeneity of the results, Appendix Figure B.2 expands on the previous figure by including the 16 ungrouped regions. This figure offers a more comprehensive understanding of the impact of the healthcare reform across different regions of Chile.

Appendix Figure B.3 presents the standardized surgery rate by macro-regions, which is defined as the ratio of the number of surgeries observed in a macro-region in 2002 to the number that would be expected over the same period if the region population had the same age-specific rates as the national population. If the rate

exceeds one, it is interpreted as excess surgeries in the macro-region relative to the national standard. The figure reveals that the patterns found in the regression analyses hold, with the highest access to surgeries pre-reform being in the metropolitan area and its vicinity, while the extreme regions have lower access.

To delve deeper into the previous effects, Appendix Figures B.4 and B.5 illustrate the age-adjusted surgery rates for the macro-zones and, by the type of health care provider and insurance, whether public or private. These figures provide additional insights into the healthcare utilization patterns across different regions and insurance types. We observe that most surgeries before the reform were for those publicly insured receiving care in public hospitals, with most of them located outside the metropolitan areas.

Furthermore, we see an interesting case in two regions in the north of Chile that are predominantly associated with mining companies, where most people have insurance from these companies. These regions show relatively high age-adjusted surgery rates in both public and private hospitals, which may reflect the favorable health care coverage provided by these companies to their employees.

3.3 Discussion

The purpose of this chapter was to assess the socioeconomic impact of the GES reform in Chile. We conducted a heterogeneity analysis that examined demographic and geographic disparities and explored differences in the effects of the reform based on the type of healthcare facility used, whether public or private, and the type of insurance, whether public or private.

Our analysis also revealed that the reform had significantly larger effects on public hospitals, indicating that it may have contributed to reducing socioeconomic disparities. While the effects of the reform were similar for men and women, there was a notable decrease in mortality among people aged 0-49. Additionally, Our findings suggest that the reform helped to narrow socioeconomic gaps in access to healthcare, as patients at public hospitals outside of metropolitan areas drove the impact of the reform on in-hospital deaths and surgeries.

Overall, our study provides a more comprehensive understanding of the heterogeneity in healthcare utilization patterns across different regions, healthcare providers, and insurance types in Chile. These findings highlight the importance of ongoing evaluation and monitoring of the healthcare reform's impact to ensure equitable access to healthcare for all individuals, regardless of their location or socioeconomic status. Policymakers and healthcare providers can use these findings to guide their

efforts to improve access to healthcare services and reduce disparities in health outcomes.

However, it's important to note that this analyses had some limitations. First, our unit of observation are the counts of the outcomes of interest within diseases age cell, we are not able to interact all of these dimensions in our heterogeneity analysis, instead, it is only based on the independent analyses of each of them, following the sub-sample strategy. Second, we used the type of insurance and healthcare provider only from in-hospital records to explore socioeconomic disparities, which may have led to an upper-bound effect regarding mortality. This approach only considers people seeking care at least once in a healthcare provider, which may not capture the full extent of disparities in mortality.

In sum, our heterogeneity analysis has shown that: i) the reform had significantly larger effects on public hospitals, suggesting it helped to reduce socioeconomic disparities; ii) had similar effects for men and women, but most of the decrease in mortality was concentrated on people ages 0-49; and iii) there was substantial variation in the impact of this reform across macro-zones, with the larger decreases in mortality outside of the metropolitan area.

Table 3.1: GES impact on health outcomes by type of health care provider

	All	Type of Hospital	
	inpatients	Public	Private
	(1)	(2)	(3)
Panel A: In-hospital Deaths			
GES	-0.069***	-0.073***	-0.025
	(0.020)	(0.021)	(0.029)
# Deaths	173,263	155,379	17,884
# Deaths Covered (as of 2003)	7,942	7,110	832
Total No. disease-age cells (obs.)	81,745	78,220	30,880
Panel B: Surgeries			
GES	0.163***	0.230***	0.008
	(0.033)	(0.037)	(0.030)
# Surgeries	790,512	563,503	227,009
# Surgeries Covered (as of 2003)	14,202	10,482	3,720
Total No. disease-age cells (obs.)	107,447	96,354	74,559

Notes: This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions on inpatient records. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and if less than 1 indicates a decreased risk for the covered group. The RRs captures the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of in-hospital deaths. Panel (b) shows the RR for the count of surgeries. Standard errors for RR are computed using the method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 3.2: GES impact on health outcomes by demographics

	Sex		Age Group		
	Female	Male	0-49	50-79	80+
	(1)	(2)	(3)	(4)	(5)
Panel A: Deaths					
GES	-0.052***	-0.038***	-0.082***	-0.047**	-0.022
	(0.017)	(0.014)	(0.022)	(0.018)	(0.029)
# Deaths	226,327	294,973	89,850	252,845	178,605
# Deaths Covered (as of 2003)	13,499	15,832	2,459	15,362	11,510
Total No. disease-age cells (obs.)	77,145	80,558	42,145	36,415	20,586
Panel B: Surgeries					
GES	0.151***	0.198***	0.211***	0.078**	0.186***
	(0.030)	(0.041)	(0.046)	(0.033)	(0.071)
# Surgeries	398,254	392,258	473,906	282,943	33,663
# Surgeries Covered (as of 2003)	7,005	7,197	7,119	6,097	986
Total No. disease-age cells (obs.)	86,310	86,171	58,294	34,892	14,261

Notes: This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The RRs captures the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of deaths. Panel (b) shows the RR for the count of surgeries. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table 3.3: GES impact on health outcomes by major geographic areas

	North	Center	Metro	Center-South	South	Austral
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Deaths						
GES	-0.013	-0.069***	-0.003	-0.077***	-0.068***	-0.057
	(0.024)	(0.018)	(0.016)	(0.018)	(0.018)	(0.043)
# Deaths	34,038	80,661	192,498	132,338	73,371	8,394
# Deaths Covered (as of 2003)	1,681	4,663	10,891	7,542	4,113	441
Total No. disease-age cells (obs.)	38,133	52,524	73,654	61,897	50,021	18,621
Panel B: Surgeries						
GES	0.128***	0.181***	0.155***	0.211***	0.083	0.113
	(0.043)	(0.039)	(0.047)	(0.030)	(0.060)	(0.096)
# Surgeries	56,474	137,197	332,623	187,852	62,470	11,551
# Surgeries Covered (as of 2003)	733	2445	6055	3044	1653	251
Total No. disease-age cells (obs.)	44,030	57,489	86,038	68,161	44,694	20,523

This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 0 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The RRs capture the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of deaths. Panel (b) shows the RR for the count of surgeries. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Geographic Areas are administrative regions grouped using the Ministry of Science and Technology definition. North: Arica y Parinacota, Tarapacá, Antofagasta, and Atacama; Center: Coquimbo and Valparaíso; Metro: Metropolitan Region; Center-South: O'Higgins, Maule, Ñuble and Biobío; South: La Araucanía, Los Ríos and Los Lagos. Austral: Aysen and Magallanes. The Metro area represents almost 40% of the population and includes the capital city. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Chapter 4

Conclusions

As the international community prioritizes cost-effective policy interventions to achieve universal health coverage (UHC),[1] the need for rigorous evidence on the impact of health reforms has increased. In this article, we studied the impact of a large health reform that guaranteed medical treatment for sick patients based solely on their diagnoses (ICD-10) and age, i.e., independent of patients' insurance and income.

Leveraging rich administrative data and the staggered coverage of disease-age groups, we showed that this reform led to a 4.4% decrease in deaths. Importantly, this result translates into a substantial number of lives saved. We calculate that before the policy, about 29,000 individuals died of diseases eligible for coverage. Therefore, approximately 1,300 deaths per year were averted thanks to the reform. In terms of monetary benefits, using Chile's median estimates of the value of a statistical life (Mardones and Riquelme; Parada-Contzen), the reform created benefits valued at USD $3.2 billion, approximately 5% of the GDP in 2004. Regarding costs, the value-added tax increment to fund this program (Missoni and Solimano) increased revenues by about USD $1 billion in one year, which is approximately a third of the benefits valued because of the lives saved. Furthermore, a simple back-of-the-envelope calculation suggests that this reform increased life expectancy by 0.29 years (as of 2003, before implementation), a significant effect that would have taken people forward close to the mortality conditions of 2005, when life expectancy was 77.78 years. See Appendix A.2 for details.

[1] In 2015, United Nations member states agreed to work towards UHC by 2030, following the World Health Organization and others' argument that UHC progress leads to improvements in overall population health. UHC means that all individuals and communities receive the health services they need without suffering financial hardship; this requires implementing specific policies that emphasize care for women, adolescents, and other vulnerable populations (The Lancet).

This research makes several contributions to the existing literature. First, it adds to the research of health insurance on health outcomes. Most studies have focused on the effects of insurance expansion based on age or socioeconomic status. For instance, Arroyave et al. shows that in Latin America, mortality disparities decreased due to doubling health insurance in Colombia, and Parker, Saenz, and Wong suggests that the "Seguro Popular" health insurance increased utilization and diagnosis in Mexico. Regarding the U.S's Affordable Care Act insurance expansion, Gruber and Sommers finds limited evidence of improved health outcomes, although Black et al. challenges its statistical power. Relatedly, Borgschulte and Vogler find a reduction in all-cause mortality for ages 20-64, and both Goldin, Lurie, and McCubbin and Miller, Johnson, and Wherry report reductions in mortality for ages 55-64, and for causes of death likely to be influenced by access to healthcare. In contrast to these studies, we assess the impact of a program with a universal scope and a novel design aimed at prioritizing early and adequate diagnoses and treatment of a specific set of diseases.

Second, it contributes to the literature on addressing mortality inequalities by showing that the intervention had differential impacts across different groups. Building on previous studies that examine the relationship between hospital ownership and health performance in Chile (Cid Pedraza et al.; Basu et al.; Alonso et al.), this research shows that inpatients at public hospitals—the largest medical bed providers serving the most disadvantaged population in the country—disproportionately benefited from this reform. In terms of demographics, we find no effects on sex-stratified samples and no effects on old age mortality compared to the groups below 80 years old. The latter is in line with the scope of the reform to prevent deaths from conditions amenable to high-quality and timely health care, usually concentrated among individuals below the ages of 75-79 (Mackenbach et al.; Nolan et al.). Moreover, the finding that the effects are larger outside of the major metropolitan area contributes to the literature on geographic disparities (Murray et al.; Bilal et al.; Mena et al.) and suggests that disease-specific reforms may be an alternative way to narrow them down.

Third, it also complements previous studies of this program. Closer to this work, Nazzal et al. conducted a survey between 2008-2009 in six public hospitals, and—focusing on acute myocardial infarction—showed the policy's early success. Likewise, Frenz et al. used survey data to show that the reform improved access to healthcare and health status, especially among lower-income Chileans. More recently, Alonso et al. documented a higher increase in early and long-term survival, for acute myocardial infarction, in public than in private hospitals. In contrast to these papers, we use the *universe* of death and inpatient records and provide *causal* evidence using a quasi-experimental research design.

Regarding the external validity of the results, we are aware that countries may

follow different paths to achieve universal health coverage, depending on their economic and historical contexts (Reich et al.). Moreover, the type of diseases targeted by reforms in other countries may differ, potentially leading to different mortality effects. Nonetheless, we hope the targeted health insurance expansion studied here can inform policymakers worldwide. Assessing how these types of disease-targeted reforms fare in different contexts is an interesting task for future work. In that context, surgery increases must be quantified in terms of cost-effective reforms for countries without developed health infrastructure, which can put important fiscal and political pressure.

Finally, the natural pathway to build on this work would be to assess the causal impact of surgeries on deaths, which is one of the limitations we encountered in this study because of the sample selection of those who seek care in hospitals. Intrinsically related to the increase in surgeries found is the increase in the wait lists in the public system in Chile. It would be interesting to study further the relation between the wait lists and mortality (Martinez et al.), depending on GES coverage, that might be related to potential negative spillovers of prioritizing some diseases.[2] All in all, we believe that these effects must be small, because of the well-identified negative effect on mortality that the reform had, but both of these questions are worth studying for surgeries and mortality as well.

[2]In 2016 Congress established a National Medical Commission to analyse the mortality effects of the wait-lists, after being informed that more than 25 thousand people in the wait list without GES coverage, and 11 thousand with GES coverage died between 2005 a 2016.

Bibliography

[1] Faustino Alonso et al. "Reducing health inequalities: comparison of survival after acute myocardial infarction according to health provider in Chile". In: *International Journal of Health Services* 49.1 (2019), 127–141.

[2] Ronald M Andersen, Pamela L Davidson, and Sebastian E Baumeister. "Improving access to care in America". In: *Changing the US health care system: key issues in health services policy and management. 3a. edición. San Francisco: Jossey-Bass* (2007), 3–31.

[3] Ivan Arroyave et al. "The impact of increasing health insurance coverage on disparities in mortality: Health care reform in Colombia, 1998-2007". In: *American Journal of Public Health* 103.3 (2013). ISSN: 00900036. https://doi.org/10.2105/AJPH.2012.301143.

[4] Sanjay Basu et al. "Comparative performance of private and public healthcare systems in low-and middle-income countries: a systematic review". In: *PLoS medicine* 9.6 (2012), e1001244.

[5] Usama Bilal et al. "Inequalities in life expectancy in six large Latin American cities from the SALURBAL study: an ecological analysis". In: *The Lancet Planetary Health* 3.12 (2019), e503–e510. ISSN: 25425196. https://doi.org/10.1016/S2542-5196(19)30235-9. https://linkinghub.elsevier.com/retrieve/pii/S2542519619302359.

[6] Bernard S Black et al. *The effect of health insurance on mortality: power analysis and what we can learn from the affordable care act coverage expansions.* National Bureau of Economic Research Cambridge (MA), 2019.

[7] Mark Borgschulte and Jacob Vogler. "Did the ACA Medicaid expansion save lives?" In: *Journal of Health Economics* 72 (2020). ISSN: 18791646. https://doi.org/10.1016/j.jhealeco.2020.102333.

[8] Brantly Callaway and Pedro HC Sant'Anna. "Difference-in-differences with multiple time periods". In: *Journal of Econometrics* 225.2 (2021), 200–230.

[9] Camilo Cid Pedraza et al. "Mortality outcomes in hospitals with public, private not-for-profit and private for-profit ownership in Chile 2001–2010". In: *Health policy and planning* 30.suppl_1 (2015), i75–i81.

[10] Clinicas de Chile. *Dimensionamiento del Sector de Salud Privado de Chile: Actualización a Cifras 2016.* Tech. rep. 2016. http://www.clinicasdechile.cl/wp-content/uploads/2018/01/INF-FINAL-DIMENSIONAMIENTO-SECTOR-SALUD-CIFRAS-2016.pdf.

[11] Clément De Chaisemartin and Xavier d'Haultfoeuille. "Two-way fixed effects estimators with heterogeneous treatment effects". In: *American Economic Review* 110.9 (2020), 2964–96.

[12] Richard C Dicker et al. "Principles of epidemiology in public health practice; an introduction to applied epidemiology and biostatistics". In: (2006).

[13] Álvaro Erazo. "La protección social en Chile El Plan AUGE: Avances y desafíos". In: (2011).

[14] Patricia Frenz et al. "Achieving effective universal health coverage with equity: evidence from Chile." [**inlang**eng]. In: *Health policy and planning* 29.6 (2014), 717–731. ISSN: 1460-2237 (Electronic). https://doi.org/10.1093/heapol/czt054.

[15] Jacob Goldin, Ithai Z. Lurie, and Janet McCubbin. "Health Insurance and Mortality: Experimental Evidence from Taxpayer Outreach". In: *The Quarterly Journal of Economics* 136.1 (2020), 1–49. ISSN: 0033-5533. https://doi.org/10.1093/qje/qjaa029. https://academic.oup.com/qje/article/136/1/1/5911132.

[16] Felipe Gonzalez et al. "Does higher education reduce mortality? Evidence from a natural experiment". In: (2022).

[17] Government of Chile. *Functional classification of the total central government expenditure 1990-2019.* Dirección de Presupuestos, Gobierno de Chile1[]Dirección de Presupuestos, Gobierno de Chile. 2021. http://bcn.cl/2pdgh.

[18] Jonathan Gruber and Benjamin D. Sommers. "The Affordable Care Act's Effects on Patients, Providers and the Economy: What We've Learned So Far". In: *Journal of Policy Analysis and Management* 38.4 (2019), 1028–1052. ISSN: 15206688. https://doi.org/10.1002/pam.22158.

[19] Helen Levy and David Meltzer. "The Impact of Health Insurance on Health". In: *Annual Review of Public Health* 29.1 (2008), 399–409. ISSN: 0163-7525. https://doi.org/10.1146/annurev.publhealth.28.021406.144042. http://www.annualreviews.org/doi/10.1146/annurev.publhealth.28.021406.144042.

[20] Johan P Mackenbach et al. "Trends in inequalities in mortality amenable to health care in 17 European countries". In: *Health Affairs* 36.6 (2017), 1110–1118.

[21] Cristian Mardones and Marcelo Riquelme. "Estimation of the value of statistical life in Chile and extrapolation to other Latin American countries". In: *Latin American Research Review* 53.4 (2018), 815–830.

[22] Diego A. Martinez et al. "Prolonged wait time is associated with increased mortality for Chilean waiting list patients with non-prioritized conditions". In: *BMC Public Health* 19.1 (2019). ISSN: 14712458. https://doi.org/10.1186/s12889-019-6526-6.

[23] Gonzalo E Mena et al. "Socioeconomic status determines COVID-19 incidence and related mortality in Santiago, Chile". In: *Science* 372.6545 (2021), eabg5298.

[24] Lene Mikkelsen et al. "A global assessment of civil registration and vital statistics systems: monitoring data quality and progress". In: *The Lancet* 386.10001 (2015), 1395–1406. ISSN: 0140-6736. https://doi.org/https://doi.org/10.1016/S0140-6736(15)60171-4. https://www.sciencedirect.com/science/article/pii/S0140673615601714.

[25] Sarah Miller, Norman Johnson, and Laura R Wherry. "Medicaid and Mortality: New Evidence from Linked Survey and Administrative Data*". In: *The Quarterly Journal of Economics* (2021). ISSN: 0033-5533. https://doi.org/10.1093/qje/qjab004.

[26] MINSAL. "Documento para la Aplicación del Sistema AUGE en las Redes de Atención del Sistema Nacional de Servicios de Salud". In: (2004).

[27] Eduardo Missoni and Giorgio Solimano. "Towards universal health coverage: the Chilean experience". In: *World health report* (2010).

[28] Rodrigo Moreno-Serra and Peter C Smith. "Does progress towards universal health coverage improve population health?" In: *The Lancet* 380.9845 (2012), 917–923. ISSN: 0140-6736. https://doi.org/https://doi.org/10.1016/S0140-6736(12)61039-3. https://www.sciencedirect.com/science/article/pii/S0140673612610393.

[29] Christopher J.L. Murray et al. "Eight Americas: Investigating mortality disparities across races, counties, and race-counties in the United States". In: *PLoS Medicine* 12.4 (2006). ISSN: 15491676. https://doi.org/10.1371/journal.pmed.0030260.

[30] Carolina Nazzal et al. "[Universal health coverage and accomplishment of secondary prevention goals among patients with acute myocardial infarction]." [**inlang**spa]. In: *Revista medica de Chile* 141.8 (2013), 977–986. ISSN: 0717-6163 (Electronic). https://doi.org/10.4067/S0034-98872013000800003.

[31] Anne Nolan et al. "Public health insurance and mortality in the older population: Evidence from the Irish Longitudinal Study on Ageing". In: *Health Policy* 126.3 (2022), 190–196.

[32] Ellen Nolte and Martin McKee. "Measuring The Health Of Nations: Analysis Of Mortality Amenable To Health Care". In: *BMJ: British Medical Journal* 327.7424 (2003), 1129–1132. ISSN: 09598138, 17561833. http://www.jstor.org/stable/25457767.

[33] Ellen Nolte and Martin McKee. "Variations in amenable mortality—Trends in 16 high-income nations". In: *Health Policy* 103.1 (2011), 47–52. ISSN: 0168-8510. https://doi.org/https://doi.org/10.1016/j.healthpol.2011.08.002. https://www.sciencedirect.com/science/article/pii/S016885101100159X.

[34] Marcela V Parada-Contzen. "The Value of a Statistical Life for Risk-Averse and Risk-Seeking Individuals". In: *Risk Analysis* 39.11 (2019), 2369–2390.

[35] Guillermo Paraje and Antonio Infante. "La Reforma AUGE 10 Años Después." In: *Documento de Trabajo* (2015).

[36] Cristian Pardo. "Health care reform, adverse selection and health insurance choice". In: *Journal of health economics* 67 (2019), 102221.

[37] Susan W. Parker, Joseph Saenz, and Rebeca Wong. "Health Insurance and the Aging: Evidence From the Seguro Popular Program in Mexico". In: *Demography* 55.1 (2018), 361–386. ISSN: 15337790. https://doi.org/10.1007/s13524-017-0645-4.

[38] Michael R Reich et al. "Moving towards universal health coverage: lessons from 11 country studies". In: *The Lancet* 387.10020 (2016), 811–816. ISSN: 0140-6736. https://doi.org/https://doi.org/10.1016/S0140-6736(15)60002-2. https://www.sciencedirect.com/science/article/pii/S0140673615600022.

[39] Benjamin D. Sommers. "State medicaid expansions and mortality, revisited: A cost-benefit analysis". In: *American Journal of Health Economics* 3.3 (2017), 392–421. ISSN: 23323507. https://doi.org/10.1162/ajhe_a_00080.

[40] Benjamin D. Sommers, Sharon K. Long, and Katherine Baicker. "Changes in mortality after Massachusetts health care reform : A quasi-experimental study". In: *Annals of Internal Medicine* (2014). ISSN: 15393704. https://doi.org/10.7326/M13-2275. www.annals.org.

[41] Liyang Sun and Sarah Abraham. "Estimating dynamic treatment effects in event studies with heterogeneous treatment effects". In: *Journal of Econometrics* 225.2 (2021), 175–199.

[42] The Lancet. "Ensuring and measuring universality in UHC". In: *The Lancet* 393.10166 (2019), 1. ISSN: 0140-6736. https://doi.org/https://doi.org/10.1016/S0140-6736(18)33257-4. https://www.sciencedirect.com/science/article/pii/S0140673618332574.

[43] Martin Tobias and Li-Chia Yeh. "How much does health care contribute to health gain and to health inequality? Trends in amenable mortality in New Zealand 1981–2004". In: *Australian and New Zealand Journal of Public Health* 33.1 (2009), 70–78. https://doi.org/https://doi.org/10.1111/j.1753-6405.2009.00342.x. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1753-6405.2009.00342.x.

[44] Verónica Vargas and Sergio Poblete. "Health prioritization: the case of Chile". In: *Health affairs* 27.3 (2008), 782–792.

[45] Anke Weber and Marie Clerc. "Deaths amenable to health care: Converging trends in the EU?" In: *Health Policy* 121.6 (2017), 644–652.

[46] Jeffrey M Wooldridge. "Simple Approaches to Nonlinear Difference-in-Differences with Panel Data". In: *Available at SSRN 4183726* (2022).

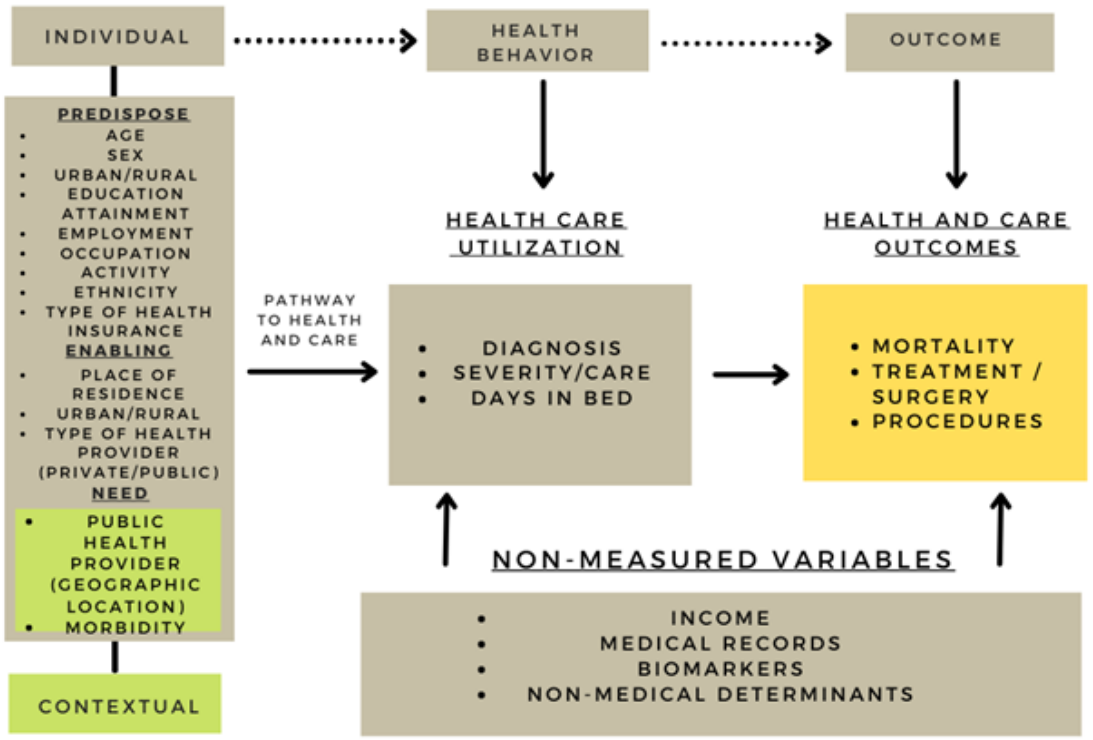
[47] Jeffrey M Wooldridge. "Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators". In: *Available at SSRN 3906345* (2021).

Appendix A

Appendix of The Impact of Disease-Specific Health Insurance Reform on Mortality: Evidence from the Explicit Health Guarantees in Chile

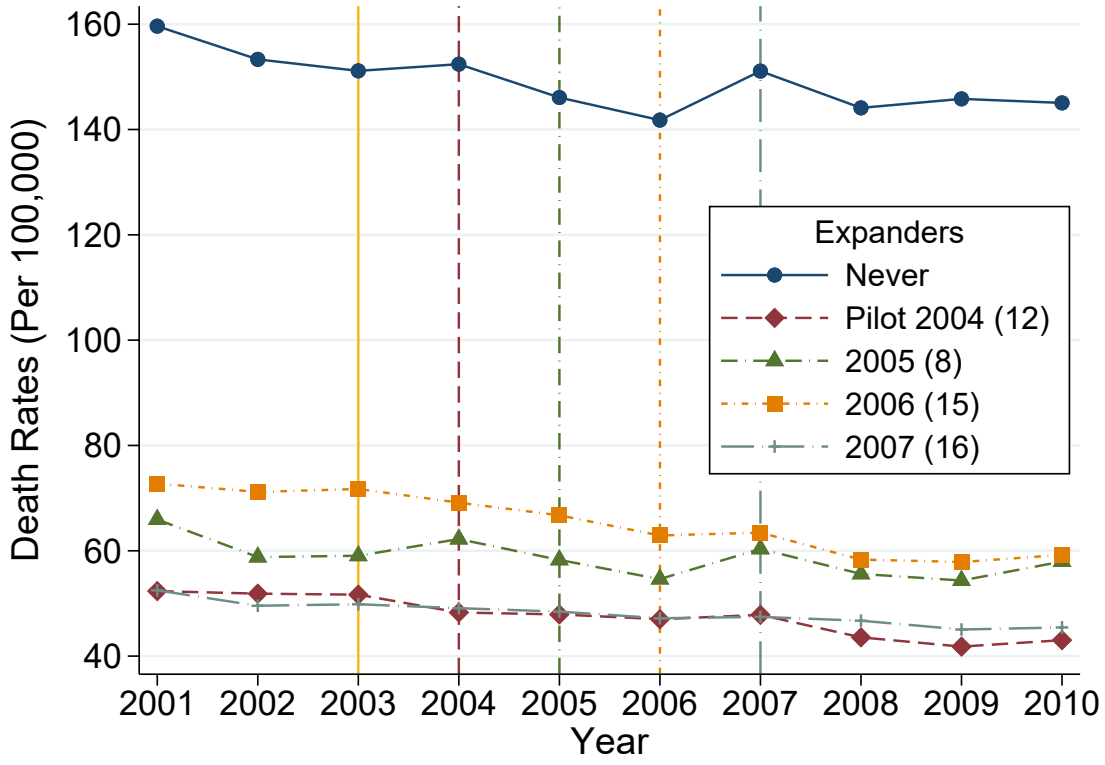
A.1 Additional Figures and Tables

Figure A.1: Conceptual Framework of the GES Reform



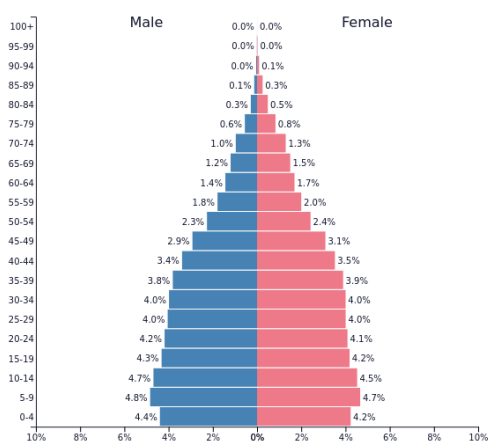
Notes: This figure shows the Conceptual Framework for the GES Reform following Andersen's revised model.

Figure A.2: Age Standardized Cause-Specific Death Rate

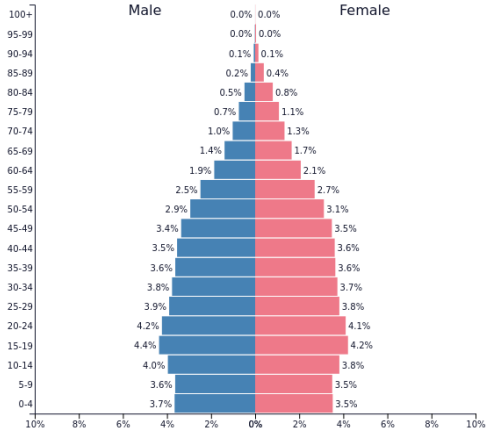


Notes: This figure shows the decrease in cause-specific death rates for each group of treated diseases; in this case, all rates are standardized using the 2001 age distribution to account for the age structure of the population. To adjust death rates, we proceed in the following way: i) we calculate crude death rates for age x as the number of deaths for each group of disease-population of age x divided by the population of age x, where x stands for 5-year age groups (i.e., 0, 1-4 years, 5-9 years,..., 85-99 years, and greater than 100 years); ii) we multiply the ratio obtained in step i) by the population share in 2001; and finally, iii) we sum across all the weighted age-specific shares obtained in step ii). The number of treated diseases in each group ("Expanders") is listed in parentheses. Vertical solid yellow lines represent one year before the expansion. Vertical dashed lines represent the year of each of the expansions. All is based on data from the Death Registry, Vital Statistics, Census, and GES eligibility rules.

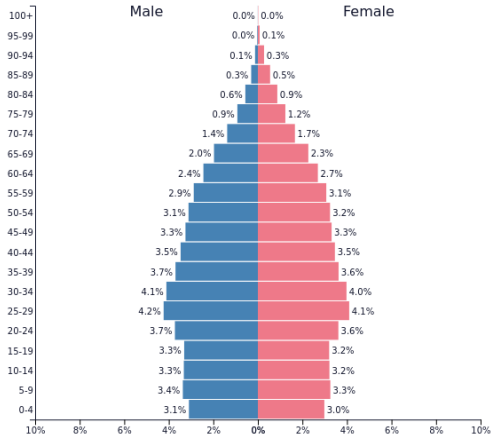
Figure A.3: Population pyramids



A. 2000, Pop: 15,32,350



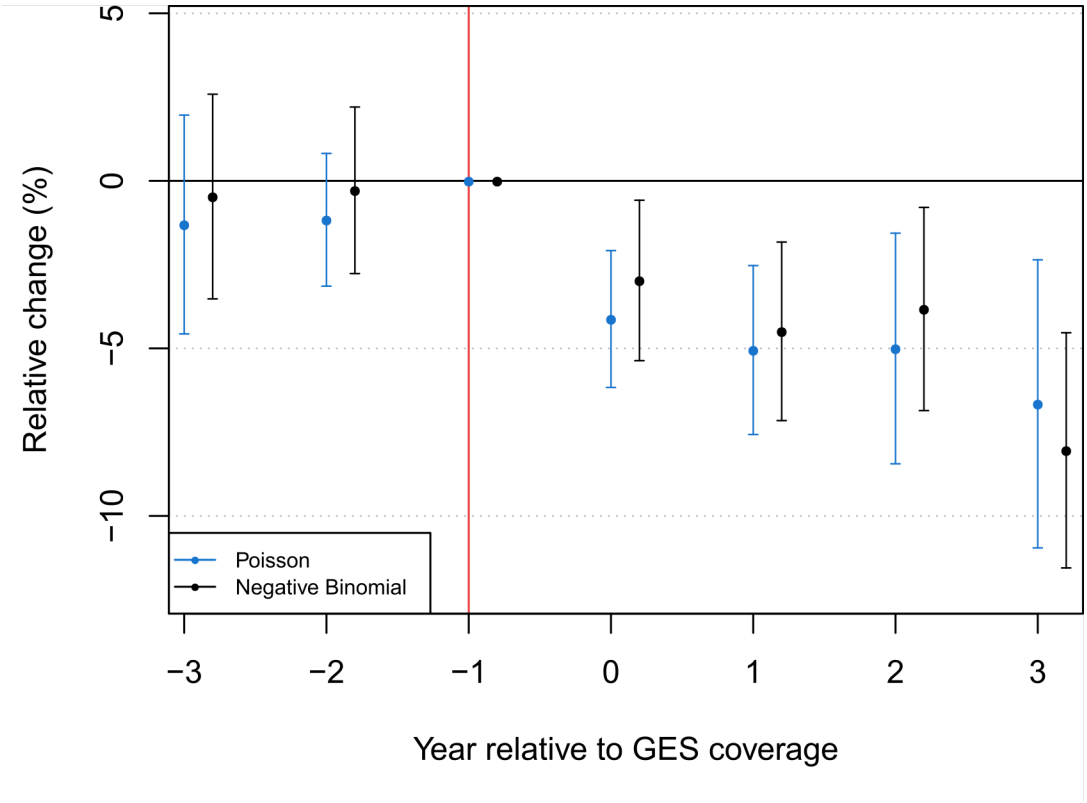
B. 2010, Pop: 17,062,531



C. 2020, Pop 19,611,208

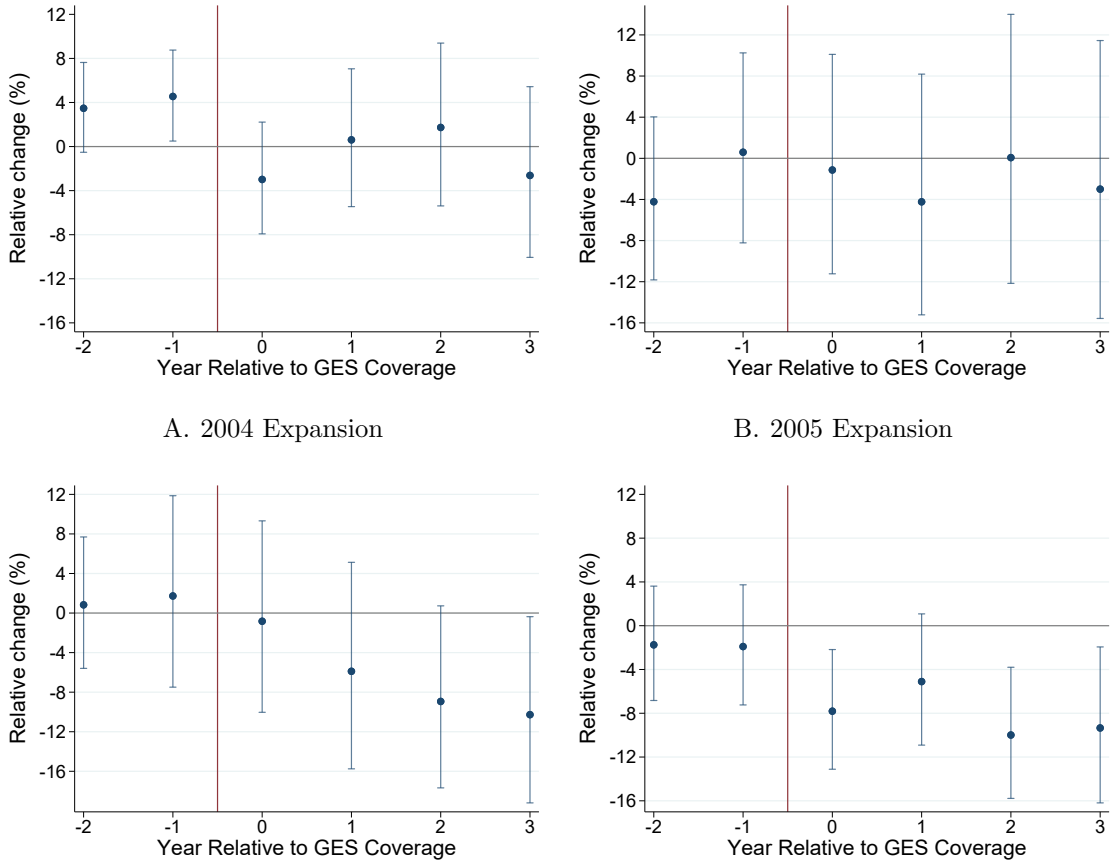
Notes: This figure shows population pyramids for Chile in the years 2000, 2010, and 2020. Source: Pyramids.net.

Figure A.4: Event study: GES impact on deaths alternative models



Notes: This figure shows the results obtained from estimating the dynamic difference-in-differences presented in equation (2.3) using the count of deaths as the dependent variable in a Poisson compared to a Negative Binomial regression. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Each RR is capturing the effect each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. The negative Binomial model was estimated using R's fixest package

Figure A.5: Event Study: GES impact on deaths, by expansion, using alternative estimation method



A. 2004 Expansion

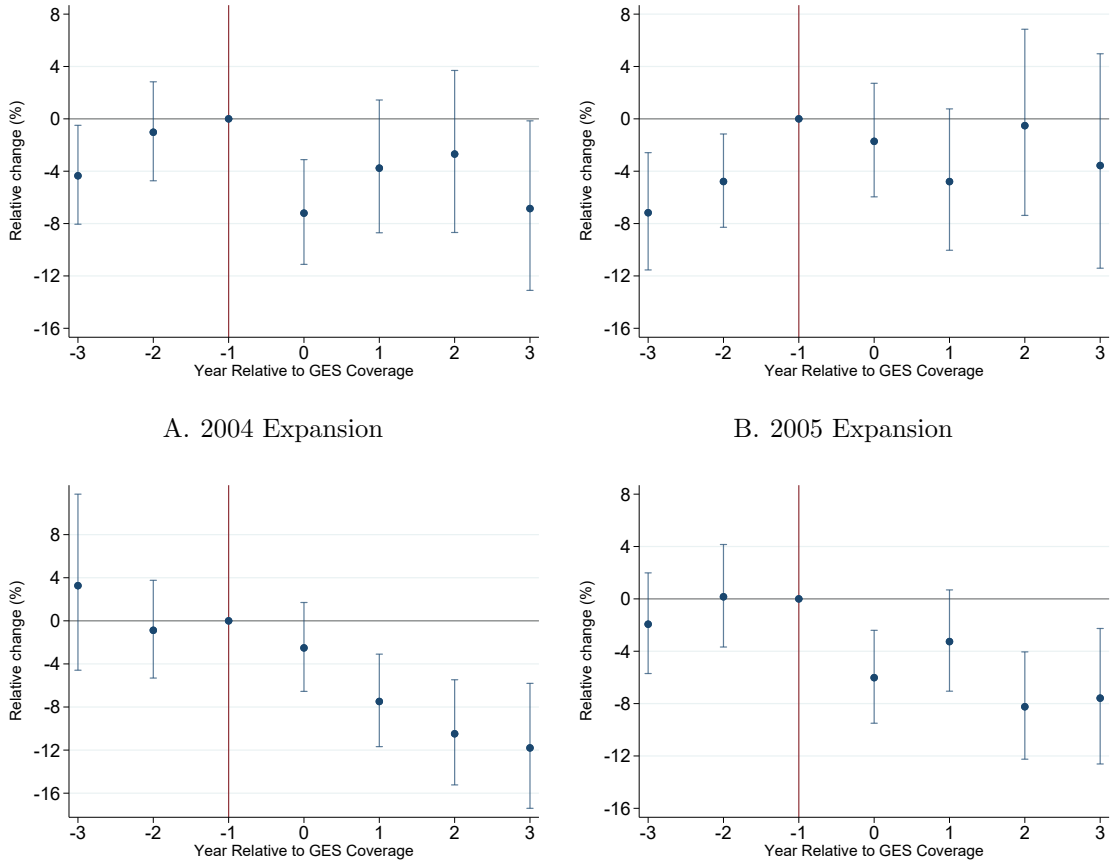
B. 2005 Expansion

C. 2006 Expansion

D. 2007 Expansion

Notes: These figures display the point estimates and 95% confidence intervals obtained from a Poisson model that is robust even if the treatment effects are heterogeneous over time or across groups. Specifically, we follow Wooldridge and estimate a Poisson regression saturated with the interaction of all treatment cohorts (GES expansions) and event time dummies. The regression includes cell and year-fixed effects. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Coefficients capture the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Figure A.6: Event Study: GES impact on deaths, by expansion



A. 2004 Expansion

B. 2005 Expansion

C. 2006 Expansion

D. 2007 Expansion

Notes: These figures show the coefficients obtained from estimating the dynamic difference-in-differences presented in equation (2.3). Each regression considers each expansion independently using never treated cells. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. The relative change reported in the y-axis corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta_k) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. Coefficients capture the effect of each period relative to one year before each group of diseases started to be covered. 95% confidence intervals for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression.

Table A.1: Health related problems: Pilot 2004

Health Related Problem	Deaths	%
Myocardial Infarction (Heart attack)	58,469	71.41
Breast cancer (15+ years old)	11,634	14.21
Lymphoma (15+ years old)	5,708	6.97
HIV/AIDS	4,160	5.08
Testicular cancer (15+ years old)	973	1.19
Diabetes mellitus, types 1	280	0.34
Psychosis (severe psychiatric disorders)	283	0.35
Spinal Dysraphism	214	0.26
Hip replacement (65+ years old)	90	0.11
Cleft lip/palate	63	0.08
Total	81,874	100.00

Notes: This table shows deaths for the health-related problems included in the 2004 pilot between 2001 and 2010. Diseases with zero deaths in the period are not included.

Table A.2: Health related problems: 2005 Expansion

Health Related Problem	Deaths	%
Pneumonias in older adults (65+ years old)	28,605	27.63
Diabetes mellitus, types 2	27,795	26.84
Arterial hypertension (15+ years old)	27,385	26.45
Heart Conduction System (15+ years old)	15,689	15.15
Prematurity	2,853	2.76
Acute respiratory infections (5- years old)	1,090	1.05
Epilepsy (between 1 and 15 years old)	122	0.12
Total	103,539	100.00

Notes: This table shows deaths for the health-related problems included in the 2005 Expansion between 2001 and 2010. Diseases with zero deaths in the period are not included.

Table A.3: Health related problems: 2006 Expansion

Health Related Problem	Deaths	%
Ischemic stroke (15+ years old)	35,199	30.95
Stomach cancer	31,207	27.44
Chronic obstructive pulmonary disease	27,809	24.45
Prostate cancer (15+ years old)	15,667	13.78
Respiratory distress in new-born	1,603	1.41
Cholecystostomy (between 35 to 49 years old)	1,495	1.31
Benign hypertrophy of the prostate	700	0.62
Hemophilia	32	0.03
Bronchial Asthma (15- years old)	10	0.01
Total	113,722	100.00

Notes: This table shows deaths for the health-related problems included in the 2006 Expansion between 2001 and 2010. Diseases with zero deaths in the period are not included.

Table A.4: Health related problems: 2007 Expansion

Health Related Problem	Deaths	%
Polytrauma with or without medullary lesion	42,646	52.99
Aneurysms	22,814	28.35
Primary brain tumors (15+ years old)	5,555	6.90
Leukemia (15+ years old)	5,370	6.67
Major burns	2,881	3.58
Rheumatoid arthritis	1,042	1.29
Cystic fibrosis	154	0.19
Alcohol/drug dependence (20- years old)	15	0.02
Osteoarthritis (Hip and Knee) (55+ years old)	3	0.00
Total	80,480	100.00

Notes: This table shows the health-related problems included in the 2007 Expansion between 2001 and 2010. Diseases with zero deaths in the period are not included.

Table A.5: Definitions of deaths more amenable to health care

Condition(s)	**ICD-10 Codes**	***Nolte & McKee***	***Sommers***	***Ours***
Infectious & Parasitic Diseases (ALL)	A00-B99		X	
-Tuberculosis	A16-19, B90	X	X	X
-Other specific infections (diphtheria, tetanus, septicemia, poliomyelitis, whooping cough, measles)	A00-09 (age 0-14), A33, A35-36, A37 (age 0-14), A40-41, A80, B05 (age 1-14)	X	X	X
Neoplasms (ALL)	C00-D48		X	
-Malignant neoplasm of colon and rectum	C18-C21	X	X	X
-Malignant neoplasm of skin	C44	X	X	X
-Malignant neoplasm of breast	C50	X	X	X
-Malignant neoplasm of cervix or uterus	C54-55 (age 0-44)	X	X	X
-Malignant neoplasm of testis	C62	X	X	X
-Hodgkin's disease	C81	X	X	X
-Leukemia	C91-C95 ($\leq$ 45 years)	X	X	X
Disorders of thyroid gland	E00-E07	X	X	X
Diabetes Mellitus	E10-E14	X	X	X
Epilepsy	G40-G41	X	X	X
Chronic rheumatic heart diseases	I05-I09	X	X	X
Hypertensive diseases	I10-I13, I15	X	X	X
Ischemic heart diseases	I20-I25	X	X	X
Cardiomyopathy	I42		X	X
Atrial fibrillation and flutter	I48		X	X
Other cardiac arrhythmias	I49		X	X
Heart failure	I50		X	X
Cerebrovascular diseases	I60-I69	X	X	X
All respiratory diseases	J00-J98		X	
-Respiratory diseases (excl. pneumonia, influenza)	J00-09, J20-99 (age 1-14)	X		X
-Respiratory diseases	J10-18	X		X
Gastric and duodenal ulcers	K25-K27	X	X	X
Gastrojejunal ulcers	K28		X	X
Diseases of appendix	K35-K38	X	X	X
Hernia	K40-K46	X	X	X
Diseases of gallbladder and biliary tract	K80-K83	X	X	X
Acute pancreatitis	K85		X	X
Infections of the skin and subcutaneous tissue	L00-L08		X	X
Infectious arthropathies	M00-M02		X	X
Glomerular diseases	N00-N07	X	X	X
Renal tubulo-interstitial diseases	N10-N15		X	X
Renal failure	N17-N19	X	X	X
Unspecified contracted kidney, small kidney unknown cause	N26-N27	X		X
Hyperplasia of prostate	N40	X		X
Pregnancy, childbirth and the puerperium	O00-O99	X	X	X
Perinatal deaths, all causes (excl. stillbirths)	P00-P96	X		X
Congenital malformations	Q20-28	X		X
Misadventures to patients during surgical and medical care	Y60-Y69, Y83-Y84	X	X	X

Notes: This table shows the classification of conditions as more amenable to health care, according to different authors. *Nolte and McKee* corresponds to the classification used in Nolte and McKee, *Sommers* corresponds to the classification used in Sommers, Long, and Baicker, and *Ours* corresponds to the classification used in this paper; which is as a combination of Nolte and McKee and Sommers, Long, and Baicker.

Table A.6: Targeted diseases, targeted cells (disease-age groups), and the total number of deaths

	Deaths			In-Hospital	
	All	Amenable	Less amenable	Deaths	Surgeries
	(1)	(2)	(3)	(4)	(5)
Panel A: Diseases (ICD-10)					
Total	1,027	317	944	1,017	1,002
Covered	315	132	284	308	309
Uncovered	763	227	668	756	742
Panel B: Disease-Age Cells					
Total	10,982	2,057	8,925	9,037	11,768
Covered	3,558	778	2,780	2,875	3,411
Uncovered	7,424	1,279	6,145	6,162	8,357
Panel C: # Deaths					
Total	521,300	96,966	424,334	173,263	790,512
Covered	264,974	62,070	202,904	77,206	195,958
Uncovered	256,326	34,896	221,430	96,057	594,554
Total No. of disease-age cells (obs.)	99,146	18,236	80,910	81,745	107,447

Notes: This table describes the sample in terms of the number of targeted diseases (ICD-10), targeted group of disease-age (ICD-10-Age) cells, and the total number of deaths. The sample only includes diseases covered in the 2004 Pilot, in 2005, 2006, and 2007 expansions, and the never-covered diseases. Panel A shows counts for diseases. In this case, *Covered* and *Uncovered* do not add up since some diseases are in both groups because the coverage is for a specific group of ages. Panel B shows counts for disease-age cells. In this case, the number of disease-age cells is not balanced for some groups of ages. This is because Poisson estimation drops disease-age cells (obs.) with all zero outcomes in the period of study. Additionally, some groups of ages are not considered because they are covered as part of later expansions outside the window used in our study, e.g Bronchial Asthma was covered by the 2006 expansions for people below 15, but in 2010 expanded the age coverage for those above 15. Panel C shows counts for the total number of deaths in our sample. The total number of disease-age cells (obs.) is the result of the covered cells in the 7-year window and the uncovered cells in the period of study.

Table A.7: Deaths covered by ICD10 chapters

	All		Never Covered		Covered in Expansion:							
					2004		2005		2006		2007	
Chapters	N	%	N	%	N	%	N	%	N	%	N	%
Diseases of the circulatory system	184,292	35.35	73,196	39.72	41,358	22.44	29,084	15.78	24,402	13.24	16,252	8.82
Diseases of the respiratory system	61,987	11.89	22,187	35.79	-	-	20,205	32.60	19,595	31.61	-	-
Diseases of the digestive system	61,552	11.81	61,497	99.91	-	-	-	-	55	0.09	-	-
Neoplasms	60,535	11.61	6,415	10.60	12,231	20.20	-	-	33,945	56.07	7,944	13.12
Injury, poisoning and certain other consequences of external causes	58,608	11.24	26,512	45.24	-	-	-	-	-	0.00	32,096	54.76
Endocrine, nutritional and metabolic diseases	27,324	5.24	7,398	27.08	219	0.80	19,589	71.69	-	0.00	118	0.43
Certain infectious and parasitic diseases	15,756	3.02	12,754	80.95	2,948	18.71	54	0.34	-	0.00	-	-
Diseases of the genitourinary system	14,315	2.75	13,758	96.11	-	-	-	-	557	3.89	-	-
Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified	7,249	1.39	7,249	100.00	-	-	-	-	-	0.00	-	-
Diseases of the nervous system	7,209	1.38	7,108	98.60	13	0.18	88	1.22	-	0.00	-	-
Certain conditions originating in the perinatal period	5,391	1.03	2,612	48.45	-	0.00	1,823	33.82	956	17.73	-	-
Congenital malformations, deformations and chromosomal abnormalities	5,274	1.01	4,873	92.40	186	3.53	-	-	215	4.08	-	-
Mental, Behavioral and Neurodevelopmental disorders	3,741	0.72	3,560	95.16	176	4.70	-	-	-	0.00	5	0.13
Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	2,928	0.56	2,896	98.91	7	0.24	-	-	25	0.85	-	-
Diseases of the skin and subcutaneous tissue	2,506	0.48	2,506	100.00	-	0.00	-	-	-	0.00	-	-
Diseases of the musculoskeletal system and connective tissue	2,353	0.45	1,525	64.81	50	2.12	-	-	-	0.00	778	33.06
Pregnancy, childbirth and the puerperium	276	0.05	276	100.00	-	0.00	-	-	-	0.00	-	-
Diseases of the eye and adnexa	4	0.00	4	100.00	-	0.00	-	-	-	0.00	-	-
Total	521,300	100	256,326	49.17	57,188	10.97	70,843	13.59	79,750	15.30	57,193	10.97

Notes: This table shows the number and percentage of deaths (from the deaths records), by reform coverage and ICD-10 chapter. We list the chapter's title according to the international version of the ICD-10, grouping deaths in our sample by the code range of each chapter.

Table A.8: Deaths covered by year

	All		Never Covered		Covered in Expansion:							
					2004		2005		2006		2007	
Year	N	%	N	%	N	%	N	%	N	%		
2001	31,707	6.08	23,877	75.31	7,830	0.00	-	0.00	-	0.00	-	0.00
2002	40,757	7.82	23,626	57.97	8,017	22.36	9,114	22.36	-	0.00	-	0.00
2003	53,427	10.25	24,096	45.10	8,261	17.84	9,534	17.84	11,536	21.59	-	0.00
2004	62,829	12.05	25,036	39.85	7,965	16.56	10,404	16.56	11,505	18.31	7,919	12.60
2005	62,535	12.00	24,766	39.60	8,171	16.17	10,115	16.17	11,482	18.36	8,001	12.79
2006	61,961	11.89	24,747	39.94	8,256	15.80	9,791	15.80	11,185	18.05	7,982	12.88
2007	67,057	12.86	27,206	40.57	8,688	16.77	11,247	16.77	11,669	17.40	8,247	12.30
2008	56,484	10.84	26,546	47.00	-	18.83	10,638	18.83	11,017	19.50	8,283	14.66
2009	47,345	9.08	27,770	58.65	-	0.00	-	0.00	11,356	23.99	8,219	17.36
2010	37,198	7.14	28,656	77.04	-	0.00	-	0.00	-	0.00	8,542	22.96
Total	521,300	100	256,326	49.17	57,188	10.97	70,843	13.59	79,750	15.30	57,193	10.97

Notes: This table shows the number and percentage of deaths (from the deaths records), by reform coverage and year.

Table A.9: Deaths covered by age group

	All		Never Covered		Covered in Expansion:							
					2004		2005		2006		2007	
Agr Group	N	%	N	%	N	%	N	%	N	%	N	%
0-14	16,564	3.18	11,129	67.19	197	1.19	2615	15.79	1,265	7.64	1,358	8.20
15-49	73,286	14.06	39,961	54.53	7602	10.37	1749	2.39	3,504	4.78	20,470	27.93
50-54	22,464	4.31	12,275	54.64	3107	13.83	1192	5.31	1,921	8.55	3,969	17.67
55-59	27,969	5.37	14,986	53.58	4013	14.35	2033	7.27	2,946	10.53	3,991	14.27
60-64	35,865	6.88	18,405	51.32	5078	14.16	3198	8.92	4,808	13.41	4,376	12.20
65-69	43,777	8.40	20,802	47.52	5963	13.62	5185	11.84	7,309	16.70	4,518	10.32
70-74	55,351	10.62	25,095	45.34	7345	13.27	7841	14.17	10,658	19.26	4,412	7.97
75-79	67,419	12.93	29,973	44.46	7853	11.65	10759	15.96	14,012	20.78	4,822	7.15
80-84	68,060	13.06	31,035	45.60	6754	9.92	12192	17.91	13,906	20.43	4,173	6.13
85-89	58,242	11.17	27,259	46.80	5236	8.99	11751	20.18	11,046	18.97	2,950	5.07
90-94	36,864	7.07	17,492	47.45	2971	8.06	8572	23.25	6,256	16.97	1,573	4.27
95-99	12,967	2.49	6,573	50.69	913	7.04	3114	24.01	1,860	14.34	507	3.91
100+	2,472	0.47	1,341	54.25	156	6.31	642	25.97	259	10.48	74	2.99
Total	521,300	100.00	256,326	49.17	57,188	10.97	70843	13.59	79,750	15.30	57,193	10.97

Note: This table shows the number and percentage of deaths (from the deaths records), by reform coverage and age group. The 0-14 age group was combined because of the few deaths reported in the age groups used in the main analysis: newborns, 1-4 years, 5-9, and 10-14.

Table A.10: Robustness of GES impact on deaths to alternative models

	Non-linear		Linear	
	Poisson	Neg-Bin	Log	IHS
	(1)	(2)	(3)	(4)
Panel A: All Diseases				
GES	-0.044***	-0.045***	-0.011*	-0.015*
	(0.014)	(0.012)	(0.006)	(0.008)
Observations	99,146	99,146	99,146	99,146
Panel B: Ever GES				
GES	-0.040***	-0.030*	-0.033***	-0.041***
	(0.010)	(0.012)	(0.012)	(0.015)
Observations	24,906	24,906	24,906	24,906

Notes: This table shows the results obtained from variations of the staggered difference-in-differences model given by equation (2.1). Column (1) presents the estimates from our main model while column (2) presents the estimates from a negative binomial regression. Columns (3) and (4) show the results obtained from linear models (OLS). Log stands for a logarithmic transformation of the outcome as Ln(deaths+1). IHS stands for the Inverse Hyperbolic Sine transformation of the outcome. For the Poisson model (column 1), *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. All regressions control for disease-age cell and year-fixed effects using the main sample. Standard errors are clustered at the level of treatment: disease-age cell. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table A.11: Pre-treatment characteristics between covered and non-covered cells

	Level (2001)		Growth (2001-2003)			
	GES	Non-GES	GES	Non-GES	$\hat{\beta}$	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
% Public Insurance	0.297	0.282	0.371	0.320	0.051	.089
% Private Insurance	0.078	0.046	0.045	0.038	0.007	.680
% High School	0.449	0.268	0.002	0.011	-0.009	.757
% Female	0.328	0.469	0.031	0.006	0.024	.344
% Married	0.359	0.380	-0.051	-0.064	0.013	.653
% Rural	0.099	0.160	-0.025	-0.022	-0.004	.817
% North	0.085	0.078	-0.018	-0.008	-0.010	.547
% Centre	0.159	0.155	-0.006	0.010	-0.016	.489
% Metro	0.462	0.367	0.019	-0.000	0.019	.524
% Center-South	0.200	0.245	-0.020	0.001	-0.021	.426
% South	0.084	0.137	0.013	-0.004	0.016	.371
% Austral	0.010	0.018	0.012	0.001	0.012	.164

Notes: This table shows pre-treatment characteristics from the death records of covered and non-covered cells. Columns (1) and (2) show the average of each characteristic among covered and non-covered cells in 2001. Columns (3) and (4) show the linear growth between 2001 and 2003 of each characteristic among covered and non-covered cells. Column (5) shows the coefficient obtained from a linear projection of growth on an indicator of GES coverage. Column (6) are the p-values associated with the column (5) coefficients. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table A.12: GES impact on deaths by GES expansion and among ever GES

	Analysis Sample				
	Ever	Only Expansion:			
	GES	2004	2005	2006	2007
	(1)	(2)	(3)	(4)	(5)
GES	-0.040***	-0.034	0.014	-0.089***	-0.058***
	(0.010)	(0.025)	(0.036)	(0.025)	(0.017)
# Deaths	264,974	313,514	327,169	336,076	313,519
# Deaths Covered (as of 2003)	29,331	8,261	10,404	11,482	7,982
Total No. disease-age cells (obs.)	24,906	78,517	79,119	76,879	87,351

Notes: This table shows the coefficients obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions on the count of deaths. Column (1) only considers ever-covered diseases and leverages differences in the timing of adoption among them for identification. Columns (2)-(5) consider the impact of each expansion separately, using never covered diseases as controls. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The Poisson estimation drops disease-age cells with all zero outcomes in the period of study. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table A.13: GES impact on deaths using alternative amenable death classifications

	Ours		Nolte & McKee (2011)		Tobias & Yeh (2009)		European Union (2015)	
	Amenable	Non-Amenable	Amenable	Non-Amenable	Amenable	Non-Amenable	Amenable	Non-Amenable
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GES	-0.071***	-0.028*	-0.063**	-0.029*	-0.047**	-0.025	-0.057**	-0.026
	(0.026)	(0.016)	(0.026)	(0.016)	(0.022)	(0.018)	(0.024)	(0.017)
# Deaths	96,966	424,334	86,324	434,976	134,481	386,819	106,780	414,520
# Deaths Covered (as of 2003)	7,693	21,638	7,121	22,210	12,741	16,590	8,807	20,524
Total No. disease-age cells (obs.)	18,236	80,910	15,538	83,608	20,346	78,800	22,216	76,930

Notes: This table shows the coefficients obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions for the count of more amenable and less amenable deaths, as classified by different authors. *Ours* corresponds to the classification used in our main analyses. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The coefficients capture the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the period of study. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

A.2 Impact on life expectancy

Life expectancy at birth was 77.33 years in 2003, the pre-reform year for which official data is reported in detail.[1] Thus, based on our estimates, we apply the relative decrease in deaths to the age-specific mortality rates from the life table and then recalculate life expectancy, finding that the reform led to an increase of 0.29 years in terms of life expectancy as of 2003.[2] Such a decline would have taken people forward close to the mortality conditions of 2005, when life expectancy was 77.78 years. Therefore, we can say that the progress in life expectancy, which would typically take two years, was achieved before it would have been without the reform.

A.3 Cost-Benefit Analysis

The value of a statistical life (VSL) might be helpful to guide policymakers in their analysis of the benefits of the reform. VSL represents risk-money trade-offs for small changes in risk. Thus estimates are usually based on the extra wages that workers receive for facing increased fatality risk at work. For instance, a worker who receives extra pay of $1,000 to face a risk of 1/10,000 has a value per unit risk (or VSL) of $1,000/(1/10,000) = $10 million, regardless of age (Viscusi). The VSL varies with countries' income levels, as do many other expenditures. For Chile, in U.S. dollars of 2022, there are numbers ranging from $0,50 to $6,33 million depending on the method and purpose (Mardones and Riquelme; Parada-Contzen). Using Chile's halfway point estimates -$USD 2,492,7130-, which also represents half of the GDP per capita in 2004, we can say that the 1,290 lives saved thanks to the GES reform (in one year) would be valued at USD $3,215,599,937, approximately 5% of the GDP.[3]

Evaluating the cost of measures taken to save people's lives is challenging. However, the tax reform implemented to fund the GES Program in 2003 brought USD $1,224,000,000 in additional revenues after one year of its implementation. There-

[1] Notice that period life expectancy assumes that people live their entire life, from birth to death, under the mortality conditions of 2003 (Human Mortality Database). In other words, this indicator implicitly assumes that the benefits from the GES reform are experienced each year over and over again as a person gets older.

[2] We compared our results using Table 2.1, column (1), and Table 3.2 columns (3-5) age-specific coefficients to compute the total and age-specific relative decrease in deaths, finding a 0.01 difference between them.

[3] All values in U.S. dollars of 2022. Exchange rate used to convert from Chilean pesos to U.S. currency corresponds to the market-observed dollar rate exchange published by the Chilean Central Bank.

fore, we can say that the cost of the reform was approximately a third of the benefits that were brought because of the lives saved.

Appendix B

Appendix of The Heterogeneous Effects of the Explicit Health Guarantee Reform on Sociodemographics and Geographics

B.1 Additional Figures and Tables

Table B.1: GES impact on health outcomes by type of insurance

	Insurance		Type of Public Insurance				
	Private	Public	A	B	C	D	NA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: In-Hospital Deaths							
GES	-0.089***	-0.065***	-0.065**	-0.069***	-0.097**	-0.0531	-0.0548
	(0.026)	(0.021)	(0.025)	(0.025)	(0.040)	(0.0385)	(0.0759)
# Deaths	19,628	153,635	61,816	69,980	7,791	11,474	2,574
# Deaths Covered (as of 2003)	971	6,971	2,811	3,381	298	370	111
Total No. disease-age cells (obs.)	33,433	77,745	58,475	51,182	21,935	24,552	10,873
Panel B: Surgeries							
GES	0.012	0.219***	0.302***	0.198***	0.230***	0.139***	-0.059
	(0.028)	(0.038)	(0.047)	(0.041)	(0.049)	(0.045)	(0.071)
# Deaths	209,559	580,953	204,198	202,431	72,784	84,651	16,889
# Deaths Covered (as of 2003)	3,760	10,442	3,582	3,874	1,206	1,262	518
Total No. disease-age cells (obs.)	74,652	96,949	73,305	69,077	43,510	49,304	23,069

Notes: This table shows the coefficients obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta)-1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The coefficients capture the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of in-hospital deaths. Panel (b) shows the RR for the count of surgeries. Insurance information is only available from the inpatient records. Private and Public correspond to ISAPRE and FONASA, respectively. The type of Public Insurance corresponds to the four types of co-payment faced by the FONASA beneficiaries as a function of their income. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table B.2: GES impact by type of health care provider removing the 2004 (pilot) expansion

	All	Type of Hospital	
	inpatients	Public	Private
	(1)	(2)	(3)
Panel A: In-hospital Deaths			
GES	-0.074***	-0.079***	-0.031
	(0.023)	(0.024)	(0.034)
# Deaths	161,269	145,224	16,045
# Deaths Covered (as of 2003)	6,078	5,541	537
Total No. disease-age cells (obs.)	78,343	75,042	29,291
Panel B: Surgeries			
GES	0.178***	0.245***	0.017
	(0.037)	(0.040)	(0.035)
# Surgeries	776,790	554,386	222,404
# Surgeries Covered (as of 2003)	12,111	9,053	3,058
Total No. disease-age cells (obs.)	104,507	94,065	72,774

Notes: This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions on inpatient records. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 1 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and if less than 1, indicates a decreased risk for the covered group. The RRs captures the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of in-hospital deaths. Panel (b) shows the RR for the count of surgeries. Standard errors for RR are computed using the method for univariate transformations on the coefficient estimated from the Poisson regression. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Table B.3: Share of deaths and surgeries in major geographic locations by public health care providers and insured

	All	In-Hospital					
	Deaths	Deaths			Surgeries		
	$\hat{\beta}$	% Public Hospital	% Public Insurance	$\hat{\beta}$	% Public Hospital	% Public Insurance	$\hat{\beta}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
North	-0.013	0.914	0.846	0.063	0.661	0.625	0.128***
Center	-0.069***	0.893	0.844	-0.069**	0.791	0.706	0.181***
Metro	-0.003	0.797	0.824	-0.046**	0.616	0.630	0.155***
Center−South	-0.077***	0.951	0.933	-0.118***	0.854	0.803	0.211***
South	-0.068***	0.974	0.923	-0.055*	0.890	0.844	0.083
Austral	-0.057	0.968	0.946	-0.214***	0.868	0.794	0.113

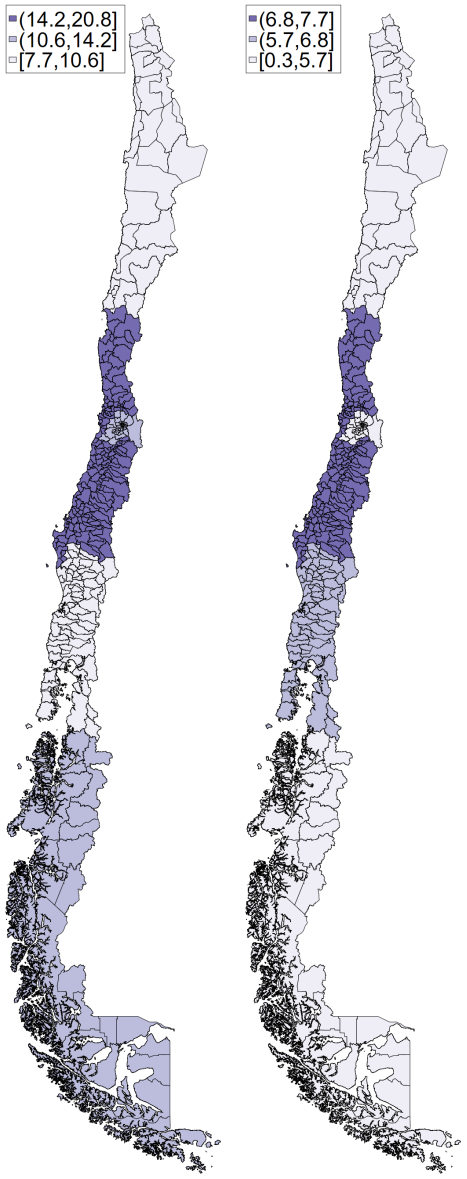
Notes: This table shows the share of deaths and surgieres in the major geographic locations by public hospitals and public insured. Health care provider and Insurance information is only available from the inpatient records. Insurance correspond to the public provision by FONASA, and Hospital, corresponds to the public health care providers. Geographic Areas are administrative regions grouped using the Ministry of Science and Technology definition. North: Arica y Parinacota, Tarapaca, Antofagasta, and Atacama; Center: Coquimbo and Valparaiso; Metro: Metropolitan Region; Center-South: O'Higgins, Maule, Ñuble and Biobío; South: La Araucanía, Los Ríos and Los Lagos. Austral: Aysen and Magallanes. The Metro area represents almost 40% of the population and includes the capital city

Table B.4: GES impact on deaths by major geographic areas and urban/rural

	North	Center	Metro	Center-South	South	Austral
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Rural						
GES	-0.028	0.022	0.026	-0.067**	-0.043	-0.015
	(0.113)	(0.046)	(0.055)	(0.027)	(0.026)	(0.132)
# Deaths	1095	7575	4521	33487	25844	731
# Deaths Covered (as of 2003)	39	379	198	1820	1294	32
Total No. disease-age cells (obs.)	5,909	17,424	12,596	34,161	31,710	3,883
Panel B: Urban						
GES	0.128***	0.181***	0.155***	0.211***	0.083	0.113
	(0.043)	(0.039)	(0.047)	(0.030)	(0.060)	(0.096)
# Deaths	32943	73086	187977	98851	47527	7663
# Deaths Covered (as of 2003)	1642	4284	10693	5722	2819	409
Total No. disease-age cells (obs.)	37,413	50,085	73,046	55,573	41,066	17,682

Notes: This table shows the results obtained from estimating the staggered difference-in-differences presented in equation (2.1) using Poisson regressions. All regressions control for disease-age cell and year-fixed effects. Standard errors are clustered at the level of treatment: disease-age cell. *GES* corresponds to percent changes by subtracting 1 from the rate ratio (RR), i.e., $exp(\beta) - 1$. The interpretation of the value of a rate ratio of 0 indicates equal rates in the two groups (covered and non-covered), a rate ratio greater than 1 indicates an increased risk for the covered group, and, if less than 1, indicates a decreased risk for the covered group. The RRs capture the average effect for all groups of diseases after they started to be covered. The Poisson estimation drops disease-age cells with all zero outcomes in the study period. Panel (a) shows the RR for the count of deaths. Panel (b) shows the RR for the count of surgeries. Standard errors for RR are computed using the delta method for univariate transformations on the coefficient estimated from the Poisson regression. Geographic Areas are administrative regions grouped using the Ministry of Science and Technology definition. North: Arica y Parinacota, Tarapacá, Antofagasta, and Atacama; Center: Coquimbo and Valparaíso; Metro: Metropolitan Region; Center-South: O'Higgins, Maule, Ñuble and Biobío; South: La Araucanía, Los Ríos and Los Lagos. Austral: Aysen and Magallanes. The Metro area represents almost 40% of the population and includes the capital city. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

Figure B.1: Macro Region variation



A. Surgeries B. Deaths

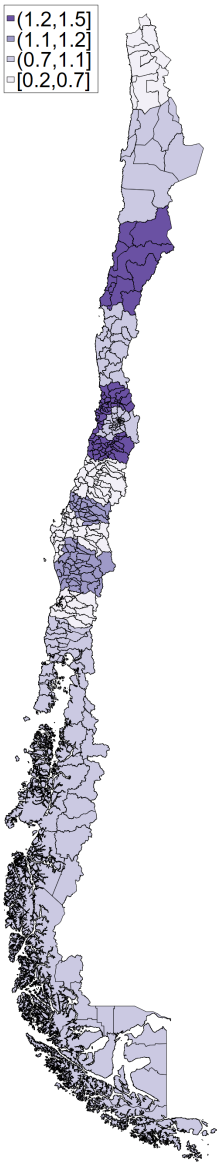
Notes: Coefficient estimates are reported in percentage points. For visual purposes, deaths coefficients are minus the effect representing a positive decrease in deaths. Surgery for Austral, and Deaths for Metro areas are non-significant (See Table 3.3)

Figure B.2: Region variation

A. Surgeries B. Deaths

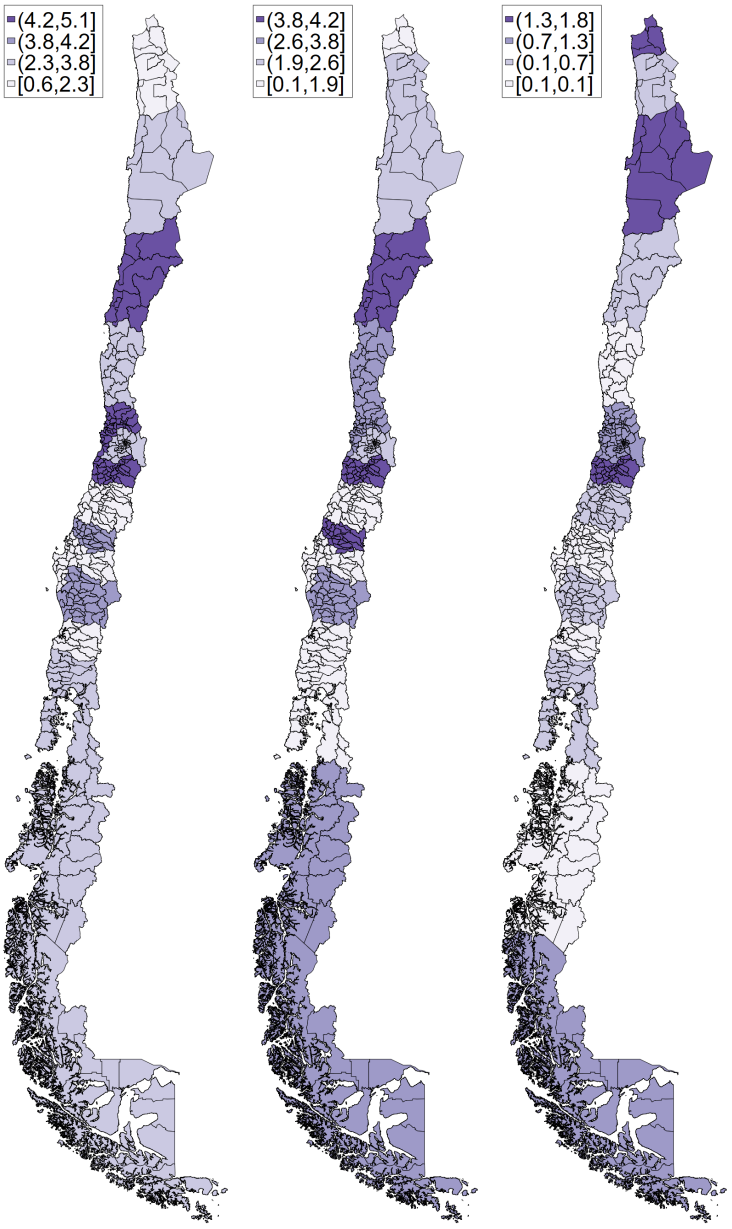
Notes: Coefficient estimates are reported in percentage points. For visual purposes, deaths coefficients are minus the effect representing a positive decrease in deaths. Surgery for Austral, and Deaths for Metro areas are non significant (See Table 3.3)

Figure B.3: Standardized Surgery Rate by Region



Notes: The standardized surgery rate is analogus to the standardized mortality ratio (SMR). Therefore, is the ratio of the number of surgeries observed in a population over a given period to the number that would be expected over the same period if the study population had the same age-specific rates as the standard population. If the rate is greater than one, it is interpreted as excess surgeries in the study population.

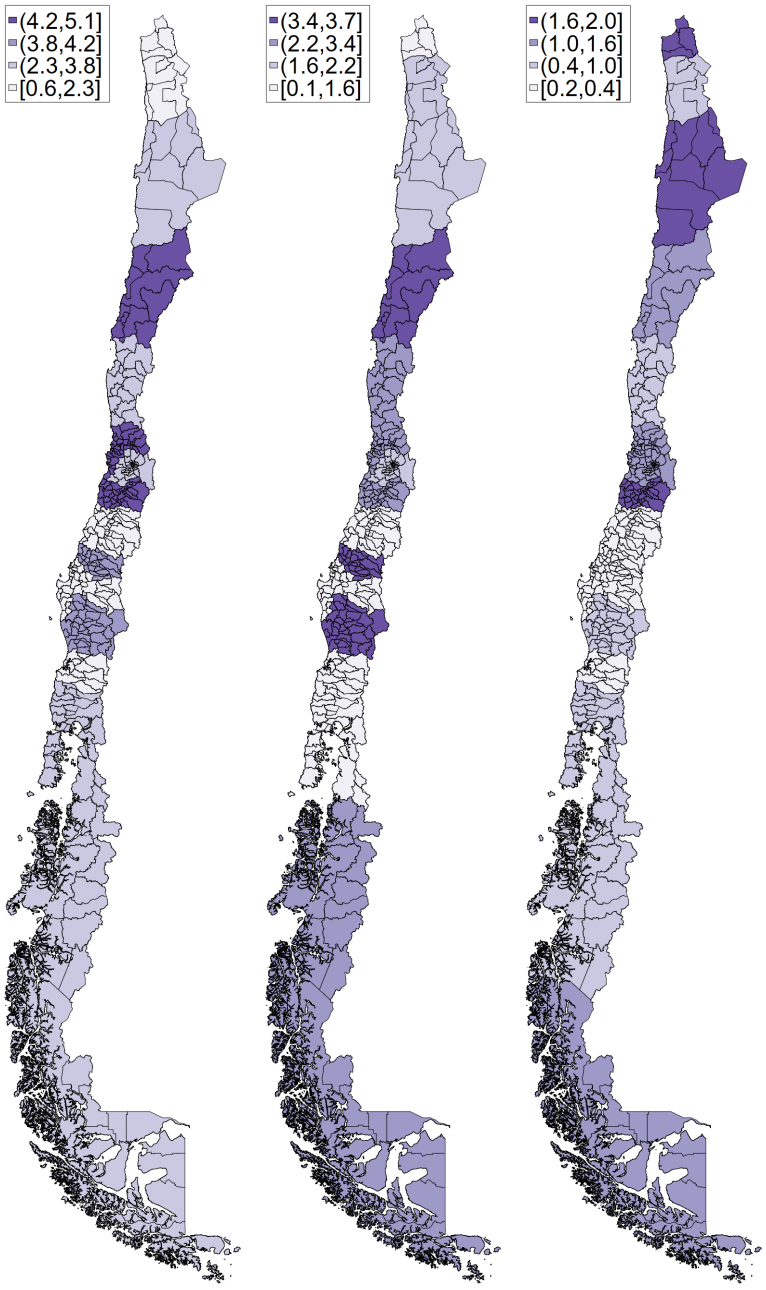
Figure B.4: Age Adjusted Surgery Rate by Region and Type of Hospital in 2002



A. All B. Public C. Private

Notes: Adjustment is accomplished by first multiplying the age-specific rates of regions by age-specific weights. The weights used in the age-adjustment of regions are the proportion of the Chilean population within each age group. The weighted rates are then summed across the age groups to give the age-adjusted rate.

Figure B.5: Age Adjusted Surgery Rate by Region and Type of Insurance in 2002



A. All B. Public C. Private

Notes: Adjustment is accomplished by first multiplying the age-specific rates of regions by age-specific weights. The weights used in the age-adjustment of regions are the proportion of the Chilean population within each age group. The weighted rates are then summed across the age groups to give the age-adjusted rate.

Bibliography

[1] Human Mortality Database. "Human Mortality Database". In: (2022). http://www.mortality.org..

[2] Cristian Mardones and Marcelo Riquelme. "Estimation of the value of statistical life in Chile and extrapolation to other Latin American countries". In: *Latin American Research Review* 53.4 (2018), 815–830.

[3] Ellen Nolte and Martin McKee. "Variations in amenable mortality—Trends in 16 high-income nations". In: *Health Policy* 103.1 (2011), 47–52. ISSN: 0168-8510. https://doi.org/https://doi.org/10.1016/j.healthpol.2011.08.002. https://www.sciencedirect.com/science/article/pii/S016885101100159X.

[4] Marcela V Parada-Contzen. "The Value of a Statistical Life for Risk-Averse and Risk-Seeking Individuals". In: *Risk Analysis* 39.11 (2019), 2369–2390.

[5] Benjamin D. Sommers, Sharon K. Long, and Katherine Baicker. "Changes in mortality after Massachusetts health care reform : A quasi-experimental study". In: *Annals of Internal Medicine* (2014). ISSN: 15393704. https://doi.org/10.7326/M13-2275. www.annals.org.

[6] W Kip Viscusi. "Pricing lives: International guideposts for safety". In: *Economic Record* 94 (2018), 1–10.

[7] Jeffrey M Wooldridge. "Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators". In: *Available at SSRN 3906345* (2021).