UNIVERSITÉ DE NEUCHÂTEL

FACULTÉ DES SCIENCES ÉCONOMIQUES

THREE ESSAYS ON CANTONAL VARIATIONS IN THE UTILIZATION AND COSTS OF HEALTHCARE SERVICES IN SWITZERLAND

PhD Thesis submitted to the Faculty of Economics and Business

Institute for Research in Economics

University of Neuchâtel

For the degree of PhD in Economics

by

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Defended on 26 March 2013

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Three essays on cantonal variations in utilization and costs of health care services in Switzerland

Paul CAMENZIND

UNIVERSITÉ DE NEUCHÂTEL

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Neuchâtel, le 27 mai 2014

Le doyen

Jean-Marie Grether

Acknowledgements

I remember health economics—taught 25 years ago by Professor Jürg Sommer during my undergraduate studies at the Faculty of Business and Economics of the University of Basel—to be the subject most fascinating to me during my early academic career. Looking back with a certain distance to this formative period of my life, various factors were responsible for my strong interest in this domain.

First, the subjects of health and healthcare provision are linked to so many aspects of human life that our preoccupation with them really starts at birth and ends with death. Questions, concerns, reflections, or decisions about health and health care are continuously present in our daily lives. It is no wonder that, to me, health economics always seemed a strongly concrete, reality-based, and useful application of theoretical scientific concepts to "real" social challenges.

Second, the application of economic concepts and instruments of analysis to the healthcare sector was still a new and, for many people, rather surprising proceeding in Switzerland in the 1980s. A critical attitude towards having a public debate about the costs and utility in the field of health care—where every effort must be taken to avoid illness or even early death—was expressed by more people than just medical doctors.

Third, some of those medical doctors noticed early that this "new thinking about limited resources" in the healthcare domain could have some unwanted consequences for them not only with respect to their workplace conditions but also to their personal incomes. It is no wonder that the discussions between physicians and health economists were often stimulating. Professor Jürg Sommer was one of these early "animators" in the field, and he had the admiration of all students for his courageous public appearances.

After completing my studies in economics at the University of Basel, another domain attracted my attention. In the 1980s, the micro-electronic "revolution" arrived in the Swiss professional world in all forms of computer-aided production processes. For many people, this change resulted in more work occurring behind computer screens. This fundamental change in the workplace produced fears that computers could replace human beings in the workforce.

To address these concerns, the Swiss cantons of Basel-Stadt and Basel-Landschaft launched a two-year research project. I served as the research assistant to the head of the research project, Professor Peter Stolz, from the University of Basel. I profited greatly from Peter Stolz's professional experience as well as his fine and extraordinary personality. Unfortunately, at that time, I was not able to complete a dissertation on "New Technologies and the Labor Market" as Professor Stolz had proposed.

Instead of moving toward academia, I engaged in a civil professional career and worked for four years as a labor market analyst and statistician at the Federal Office of Industry and Labor (BIGA) in Bern. While in Bern, my relationship with the University of Basel continued; I was invited to be involved in a specialized program for constructing and analyzing health market flow models in the Research Unit for Labor Market and Industrial Economics (FAI).

I was privileged to become acquainted with Professor George Sheldon, the director of the FAI and dean of the Faculty of Business and Economics at Basel University. Sheldon and his collaborator, Roland Theiss, both brilliant economists and fine people, were the first to teach me how to work with mainframe computers and large databases. These skills proved useful for the next steps in my professional life.

The year 1996 was a special one for the Swiss healthcare system as well as for my professional career. The revised Federal Health Insurance Law (FHIL) came into force; thus, the Federal Statistics on Mandatory Health Insurance (MHI) were revised and adapted to the new legal conditions.

The departmental manager of the Federal Office of Social Insurances in Bern, Dr. Till Bandi, solicited me for this project. I was glad to take on this challenge, because this new job allowed me to combine my skills in statistics and management of large databases with my "old love," health economics. The result of this work was a statistical handbook, *Statistik der obligatorischen Krankenversicherung*, which has remained in use since its original publication in 1996.

After this intense phase of conception, creation, and production of the new Swiss MHI statistics, I resolved to extend my skills further into the analysis of statistical data. In the 1990s, I pursued postgraduate study in applied mathematical statistics and received the Diplôme Postgrade en Statistique from the University of Neuchâtel.

This master's curriculum was not only broad and interesting but also challenging for a more-or-less full-time professional and father to two young sons. It was only there, however, that I learned the concepts and underlying assumptions of most important statistical models, particularly in the area of multivariate statistical analysis. During this coursework, I collaborated with academics in the field from all over the world. Professor Ali Hadi from Cornell University and Professor Ludovic Lebart from the Ecole Nationale Supérieure des Télécomunications in Paris were of particular note. Under the supervision of Professor Lebart, in the autumn of 2000, I completed my master's thesis in statistics: "Multivariate Descriptive Statistical Analysis of the Social Health Insurance System in Switzerland."

At the same time, political discussions took place regarding the creation of a new institution in the field of empirical data analysis in the Swiss healthcare sector. In 2001, the new Swiss Health Observatory (Obsan) was founded in Neuchâtel and had to be equipped with scientific staff. The founding director of the Obsan, Professor Peter C. "Pit" Meyer, invited me to help cultivate the organization, staff, and the scientific competences of the institution.

Working with Pit Meyer, now the director of the health department at Zurich University of Applied Sciences in Winterthur, was a satisfying and intense experience. Professor Meyer has been able to drive himself to realize his project despite its mammoth proportions, yet he is a warm-hearted and humorous person. His leadership was one of the most important factors in successfully establishing the Obsan in the field of Swiss empirical health data research within the first five years after its founding.

In 2006, I planned one more formal continuing education degree, with a dissertation in the field of health economics. The project aimed to assess why large regional differences are present in Swiss healthcare utilization and costs. I proposed the project to Professor Claude Jeanrenaud from the University of Neuchâtel, who immediately agreed to support and supervise the project. I first executed a comprehensive literature review on the subject of international and national differences in regional healthcare costs. The study was published in 2008 in an Obsan editorial series under the title: "*Erklärungsansätze regionaler Kostenunterschiede im Gesundheitswesen*."

Professor Jeanrenaud then proposed that I complement the thesis with three empirical applications in the form of journal essays. This work took its time, mainly because my budget was limited as interim director of the Obsan from 2008 to 2009. I hope the empirical essays (only the one in Chapter 4 has been published in a recognized journal up to now) summarized in this PhD thesis were worth the “suffering.” In any case, the dissertation completes 25 years in applied scientific studies and research.

To conclude, I would like to thank those who supported this project for the last six years through their contributions and encouragement. In particular, I thank my supervisor, Professor Claude Jeanrenaud, the three members of the Committee for their extended and most valuable feedback, as well as my superiors during the project at the Obsan, Dr. Stefan Spycher and Dr. Monika Diebold. I also would like to thank all my colleagues from the Obsan family: Lucy, Laila, Nathalie, Gaëlle, Hélène, Danièle, Sylvie, Dimitri, Stéfane, Florence, Sonia, Luca, Maik, Sacha I, Sacha II, Virginie, Daniela, Sabine, Isabelle, Valérie, Mara, Sarah, France, Marcel, and Andrea.

By far, I owe the most to my wife and best friend, Christa, my companion for the last 25 years and the mother of my two sons, Moritz and Domenic. Christa was always ready to help me carry on my academic escapades and encouraged me to continue. She is the love of my life, and I dedicate this work to her.

Executive Summary

This document consists of three Parts, of which Part I provides a general introduction to the institutional and empirical framework around cantonal variations in costs and utilization of healthcare services in Switzerland (CH). Therefore, a more *theoretical introduction* is offered by presenting important aspects of the meaning of health care in the framework of health economic theory and a short overview about the research history of the explanation of different levels of healthcare costs and utilization and their temporal and spatial trends. This introduction is followed by a presentation of the main components comprising the construction, functioning and funding of the *Swiss healthcare system*. A short comparison of levels of and trends in healthcare costs to those of other Western countries reveals that the situation for Switzerland is not especially unique. More unique to Switzerland are the strong variations of regional healthcare costs per person observed *within the country*, as they can widely vary across cantons—even by factors of 2 or 3.

Part I of the document continues with an overview on *Switzerland's health data situation* and reveals that its most critical weaknesses exist in the areas of outpatient healthcare provision and of epidemiology. Part I terminates with a presentation of the *literature* overviewing international and national differences in regional healthcare costs. The review concludes that it is challenging for health economics to provide consistent answers to many of the important research questions pertaining to the field of regional healthcare cost and utilization differences. The most frequently cited causes of this difficulty are the complexity of the healthcare systems and the crucial dearth of broadly recognized theoretical models and available data. A recently presented model (Chandra and Skinner 2012; Skinner 2012) was considered to be a good starting point for a more systematic analysis of geographic variations in healthcare costs and utilization.

One agreement in the literature about the methodological findings is obvious: when explaining regional health differences, it is advantageous to account for levels of and trends in healthcare costs (or utilization) simultaneously. However, one has to be aware that different sets of variables can influence each dimension. Thus, by being able to combine cross-section and time-series analyses, a panel econometric approach seems to be the most promising statistical-technical instrument for tackling these types of research questions.

Moreover, because the prices paid in the health sector (e.g., the cantonal taxpoint values in Switzerland), the volumes of care (e.g., the number of per capita GP consultations), and the medical practices applied (e.g., the average number of taxpoints used per consultation) can—again—be influenced by different sets of factors, separate analyses of these three main components of healthcare costs is preferable. Moreover, the literature review identifies individual data (i.e., the individual patient, the individual insurance policyholder, or the individual healthcare provider) and geo-coded information[1] as the statistical and geographical level that offers the most possibilities for such research. Unfortunately, the Swiss health data normally do not allow in-depth analysis on such individual levels.

In Part II of the document, three essays containing concrete analyses of regional differences in costs and in actual and future utilization of healthcare services in Switzerland are presented; none of these empirical investigations goes beyond the cantonal level. The *first essay* investigates the factors associated with cantonal differences in the utilization of mandatory health insurance (MHI) services between 2000 and 2007 by applying panel econometric (fixed effects) models. For variations in utilization for each of the six largest MHI service provider domains—viz., general practitioners, medical specialists, hospital inpatient care, hospital outpatient care, medication and nursing homes—significant factors that are correlated with utilization frequency over time and across cantons can be identified.

In particular, a greater density of service providers tends to be significantly associated with the per-capita consumption of healthcare services. On the demand side, older, more urban and wealthier populations with more deprivation problems summarize the principal positively correlated factors. Financing characteristics in the form of high deductibles or managed care instruments can also play a role in the utilization level of healthcare services, although some large difficulties[2] were faced in confirming their effects empirically. Finally, the general time trends describing the accelerating utilization of outpatient drugs, nursing homes and outpatient hospitals are presented in contrast to the declining trends observed for inpatient hospitals, GPs, and specialist services in private practices.

1 Of course, in reality, the exact research question actually determines whether individual-level data are needed; however, most of the time, data aggregation (if needed) is possible, but desaggregation is not.

2 The main methodological challenges were endogeneity problems (omitted variables and variable selection biases) and ecological fallacies (see Chapter 4).

The main contribution of the first essay of the thesis is its being the first such work to analyze spatial and temporal differences in *quantities* instead of *costs* of healthcare service domains in Switzerland. Moreover, the testing of a constant set of 12 explanatory variables across the six healthcare service domains allows a bi-directional interpretation of the results. In addition to understanding how each of the six target variables is interrelated with the whole set of regressors, one can learn more about how each purportedly influential factor is individually associated with all six healthcare service domains.

The *second essay* in Part II begins by presenting the large differences in average annual per-bed costs between individual nursing homes and between nursing homes grouped by cantons. The paper tries to identify empirically some explanations for these sizable per-bed cost variations. At the same time, the assumed existence of two-levels of explanatory factors (viz., individual and cantonal levels) is taken into consideration by modeling them with regression estimations in multilevel form. Moreover, besides the variation of total costs per bed and per year, the variations of the annual per-bed costs of accommodation and assistance and the annual per-bed costs covered by the MHI are calculated separately.

Because the data from 2006 alone were available for the research presented in the second essay at the time of its conception, it was decided to approach this study with only a single year being analyzed in a cross-level setting. This approach clearly has its limitations, but it did not preclude employing more sophisticated panel data approaches at a later date. Such a limited model explains variations in the annual per-bed costs between cantons fairly well, but quite a share of variation within cantons remains unexplained. Because no ideal indicator was available for the data on the hotel service standards of Swiss nursing homes, this result was not surprising—especially regarding annual per-bed costs of accommodation and assistance. However, the operationalized variables—such as the number of days invoiced per bed and year (i.e., occupancy rate), the intensity of nursing time spent per patient and day, the qualification level of the personnel, the relative number of non-medical employees, and the cantonal wage index—were significantly correlated with all three cost indicators.

The essay admits to the difficulty faced in deriving recommendations for policy-making authorities from these results. Cantons should at least *monitor* their nursing home costs and financing continuously—in particular, their costs for assistance and accommodation. Should increasingly large numbers of individuals and their families out of the growing number of people with chronic illnesses be unable to pay these costs out of their own pockets in the coming years, the cantons might be forced to intervene.

The *third essay* of Part II analyzes regional differences in the utilization of somatic acute care beds in Swiss hospitals. A description of cantonal population age structures and trends and hospital utilization patterns in 2010 is followed by calculations of ranges of cantonal acute care hospital volumes through 2030. Originally developed by researchers at the Swiss Health Observatory and the Statistical Office of Canton Vaud (VD) for the statistical support of hospital planning processes in individual cantons, a projection model is applied for the first time in this study for all 26 cantons *simultaneously* and allows a direct comparison of the results across cantons and with the country as a whole as well as calculations of national-level results for medical branches. The projection model realizes a systematic link between Swiss medical statistics for hospitals and official cantonal population scenarios. Various hypotheses on future length-of-stay (LOS) trends in Swiss acute care hospitals are simulated with the model.

The most important results of the study are the following: the national number of hospital days required through 2030 should increase no more (or only slightly more) than the population increases. While an increase of hospital days between 5 percent and 13 percent is expected in the two “middle” scenarios of the model, the population will grow 11 percent between 2010 and 2030 in the official “average” demographic scenario. This rather positive outcome on the national level is the result of major differences between cantons. Some cantons will have to deal with increases of hospital days of approximately 30 percent, whereas in other cantons hospital days will rise less than 5 percent. Moreover, treatments typical for older patients, such as cardiology and vascular medicine treatments, will clearly be more necessary in 2030 than medical branches with very young patients, such as neonatology or obstetrics.

Part III provides some *specific conclusions* for the Swiss healthcare system with its characteristics of regulated competition and strong federalist structure. As a strategy of analyzing and comparing healthcare cost components defined as being *low aggregated* (e.g., individual health service domains or providers and individual cost components, such as quantities and prices) is favored and targeted in the three empirical essays of Part II, it seems important that such detailed analyses should afterwards be complemented by an attempt to draw an overall picture of the results. Accordingly, an applied synthesis of the results for two exemplary cantons—one canton with low (Obwalden OW) and one canton with high per capita healthcare costs (Geneva GE)—is presented in the Excursus of Part III.

Without yet having executed the necessary empirical work, proposals are made in the Excursus about how cantons might be distinguished by some of their characteristics on the demand and supply sides of the healthcare system. On the demand side, cantons may have a more "*integrated*" or a more "*globalized*" population. Concrete characteristics that assign a cantonal population to one or the other type could be derived from their different economic conditions (e.g., income, assets, and their distributions), the importance of social-economic exclusion (e.g., unemployment, receipt of benefits), the average physical and mental health status, and the actual and future age structure (including future requirements of health care).

On the supply side, two different types of cantons are proposed as well. First, there might be the "*peripheral-type scheme*" of a cantonal health provision system. Such a health system is focused on primary care and nursing homes, and it is characterized by a modest health provision infrastructure with only a few active specialists, with many health services being purchased in other cantons. Second, the "*center-type scheme*" of a cantonal health provision system is proposed. Such a system is characterized by a large (university or principal) hospital that is surrounded by many independent specialists and pharmacies. This system, in contrast, *attracts* patients from other cantons.

The document concludes by offering a few suggestions for future research. Rather concrete propositions were made in the three empirical articles of the thesis. First, they were mainly about more sophisticated *methodological approaches*: the use of instrumental variables and two-stages least squares estimations in the first article, the use of panel data models with additional regressors in the second article, and the integration of additional variables such as sex, morbidity trends, and future changes of regional patient flows in the third article. Second, extensions concerning the *data* were required: the necessity of always working with statistical data on an aggregated level might be the most significant problem this thesis faces throughout. Moreover, more detailed domains of health service providers could be analyzed in the first article, a search for better variables concerning hospitality standards and cantonal regulations in nursing homes is proposed in the second article, and a more precise analysis of hospital cases with very long LOSs would be useful in the third article. As a more general recommendation, more research about possible trends in the future health status of aging populations in Western societies was proposed. Special models to simulate such quantitative calculations exist and could be translated to the case presented by Switzerland.

Keywords: geographical (cantonal) variations, utilization of healthcare services, healthcare costs, levels and trends, prices, volumes (quantities), medical practice (variations), health economic theory, demographic scenarios, aging of populations, health status, (Swiss) healthcare system, (types of) cantonal healthcare systems, regulated competition, federalist structure, (Swiss) health data, aggregated and individual data, mandatory health insurance (MHI), health services provider domains, nursing home sector, costs of accommodation and assistance, (somatic) acute care hospitals, hospital cases, hospital days, length-of-stay in hospitals (LOS), hospital planning process, medical branches, panel econometrics, multi-level regressions, model projections, scenarios.

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"Die Gesundheit ist zwar nicht alles,
aber ohne Gesundheit ist alles nichts."

Arthur Schopenhauer
Philosopher and physician, 1788 - 1860

Part I: General introduction and background

1 General introduction

1.1 Introduction and overview

This document describes some of the important aspects of my work during the last six years in the areas of healthcare systems and regional differences in the utilization and costs of healthcare services. Before I start with a description of some economic aspects and consequences of healthcare production and consumption, I would like to discuss the term "health" to assist in answering the research questions posed in this document.

The most widely known definition of health is the one established by the World Health Organization in 1946 (WHO 1948). In this framework, health is "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity." It is no wonder that this expansive definition of health by the WHO often has been criticized, because it is too broad and not realizable, particularly from an economic point of view.

However, the WHO definition seems quite useful because it points most clearly to the existential importance attached to health by human beings and hints at the special characteristics of "health as an economic good" (see Section 1.2). Moreover, the broad definition anticipates the modern conception of health in public health theory. Health is the result of an interplay of manifold health determinants, such as age, gender, genetic dispositions, lifestyle factors, social and communal networks, life and work conditions, and general conditions of the socioeconomic, cultural and physical environments (Meyer 2008). Consequently, it clearly expresses that the good health of populations and of individuals does not exclusively depend on the availability and the use of a well-developed healthcare system.

Whenever the focus is distinctly placed on *healthcare systems* in this document, it should be kept in mind that these systems comprise only one set out of the many input factors influencing the complex process known as the "production of health" (Wilkinson and Marmot 2003). Otherwise, the healthcare system is, indeed, a Western country's most important "health producer," at least if one refers to the directly measurable consumption of economic resources.

Part I of the document contains a general introduction of the institutional and empirical framework describing the cantonal variations of costs and utilization of healthcare services pertaining to Switzerland. Section 1.2 presents a few important aspects of the meaning of health care in the framework of health economic theory. It discusses some of the most important specialties of the corresponding healthcare and health insurance markets. By providing such a background, explanations become easier for why increased levels of healthcare costs[3] and why their temporal and spatial trends have become major problems in the politics of many Western societies (Section 1.3).

The theoretical introduction provided in Chapter 1 is followed in Section 2.1 by a brief presentation of a few main components and specialties concerning the construction and functioning of the Swiss healthcare system. In Section 2.2, an overview of the concrete situation concerning healthcare costs in Switzerland is presented. Statistical information about the levels of and trends in Swiss healthcare costs to those of other Western countries are compared. After that, the sectional and regional structures of Swiss healthcare costs and—in more detail—the costs covered by mandatory health insurance (MHI) are presented in Section 2.3. An overview of the Swiss healthcare *data* system (Section 2.4) concludes the Chapter.

Following this theoretical, institutional, and statistical background, Chapter 3 continues with a short presentation of a comprehensive literature review (Camenzind 2008) about the subject of international and national differences in regional healthcare costs. That study had been executed in favor of creating sufficient theoretical and methodological expertise before engaging in personal empirical research. Separate summaries of the content and methodological findings of the literature review are cited in Sections 3.2 and 3.3.

The three empirical essays presented in Part II of the document are all about differences in utilization or costs of health services in Switzerland. The political importance (see Section 2.3), the availability of useful statistical data (see Section 2.4), the methodological findings from the international literature review (see Section 3.3), and, last but not least, proximity to the authors' professional work in daily business, were important contributing elements to the development of the three concrete models. Part II explicitly analyzes the utilization of overall MHI services, the cost differences per bed in Swiss nursing homes, and the future

[3] I use "healthcare costs," "healthcare expenditures," and "healthcare expenses" as synonymous terms throughout the document.

requirements of inpatient healthcare volumes in acute care hospitals. Various methods, such as panel econometrics, multi-level regressions, and model simulations, are applied.

The first empirical model in Part II investigates the factors associated with cantonal differences in the utilization of healthcare services in the MHI (one of the major components of Swiss healthcare costs) from 2000 to 2007. It uses one frequently applied variant of panel econometric models in the literature: the fixed-effects models. The second work in Part II focuses on cantonal and institutional differences of annual per-bed costs in Swiss nursing homes. Multilevel analysis, which is suitable for hierarchical data structures, was therefore adopted. The third empirical model in Part II analyses regional differences in the utilization of somatic acute care beds in Swiss hospitals. The perspective is changed here from historical investigations to a look into the future. A simulation model with projection results for the cantonal utilization of acute care hospitals until 2030 is presented.

Part III gives a short overview of the document and presents an applied synthesis of the results for two exemplary cantons. The objective is to summarize the main findings of the introductory Chapters and the three empirical essays in the document for one canton with very low and one canton with very high per capita healthcare costs. In conclusion, a few potential suggestions for future research are added.

1.2 Health care as an economic commodity

The health economics literature (Hurley 2000) distinguishes among four bundles of particular characteristics marking health care as an economic commodity. First, demand for health care must be seen as a derived demand for health; second, the production and consumption of health care is accompanied by large positive and sometimes negative externalities; third, there exist important informational asymmetries between different players in the healthcare market; and fourth, significant uncertainties concerning the “real” requirements for health care and the effectiveness of healthcare services are present. In comparison to many standard economic goods described by economic theory, the commodity of “health care” is particular in the sense of being affected by all four of the above-mentioned characteristics, which themselves are also interrelated.

The first point, the demand for the commodity of health, becomes manifest if a household invests in the conservation of the health status of its members (health promotion services), the restoration of a disturbed health status (cure services), or in the maintenance or better dealing with a disturbed health status (care services). In this view, demand for health care and its services is a *derived* demand for health (Grossman 1972). In other words, it is a demand conditional on being ill or conditional on avoiding becoming (more) ill.

Moreover, an intervention provided by the healthcare system—such as prescribing a drug to treat a patient's being overweight—is only one of the possible inputs in the process of health production. Other measures that might be taken to decrease weight include self-motivated change in nutrition or physical activity by the patient. This variety of measures that can be taken also illustrates one of the main reasons why it is quite difficult to assess the effectiveness and efficiency of professional healthcare interventions or services: perhaps another intervention outside the healthcare system (see Figure 1) would have been more effective, more efficient, or both.

Once the decision is taken to confront a health problem using an intervention provided by the professional healthcare system, such a measure or treatment can be analyzed for its efficiency on three different dimensions (Hurley 2000). The first dimension, *technical* efficiency, is achieved when the providers of healthcare services are organized in a way that a given output is produced with minimal (*physical*) inputs. The second dimension is cost-effectiveness or *productive* efficiency and is achieved when the providers of health care organize their production in a way that the *costs* of the production of a given output are minimized. The third dimension, called the *allocative* efficiency, concerns the society and the economy as a whole. Here, the question is whether the levels of national or regional healthcare expenditures are optimal, if they are compared with other politico-economic goals of the society, such as a high level of education or the best possible public safety.

The second characteristic of health care as a commodity—viz., positive or negative externalities appearing during the production and consumption of health care—is most apparent in the field of transmissible diseases. If a person is ready to bear the costs of an immunization against a disease or to apply a protective measure against the transmission of a disease, he or she also creates value for other individuals in the society.

Moreover, the healthcare system itself produces positive externalities by its sheer existence. The best example for this is the setting up of an overall-coverage emergency healthcare system. Such services are available at special and (from the individual's perspective) rare moments when they are urgently needed. Finally, as an example of a *negative* externality in the healthcare sector, the medically inappropriate (over-)use of antibiotics and the consequent resistance phenomenon (Filippini, Masiero, and Moschetti 2006) can be mentioned.

The third bundle of features characterizing health care as an economic commodity involves informational asymmetries. Economists understand this notion to reflect a situation in which the players on one side of the market dispose of more information about relevant aspects of the market transaction than the players on the other side. In real life, nearly everyone has been confronted with informational asymmetries between patients and physicians. With respect to interacting with physicians (or other health providers) in private practice or hospitals, a level-headed evaluation of performance and price is often not possible for patients. Consequently, the information needed to make a fully informed choice is not available, not given to the patient, or is provided in a manner that is too complicated to be useful. This circumstance is particularly true if time is scarce, as in emergencies. In general, physicians are in much better positions to evaluate the necessity, the urgency, the chances of success, and the possible consequences of the treatment (or non-treatment) of the patient.

This constellation can be a problem in situations in which the supplier of the healthcare service is exposed to incentives for which his own financial interests are optimized if he delivers the most numerous or the most expensive services. Particularly in healthcare systems with fee-for-service remuneration schemes[4], physicians and other healthcare providers are induced to treat patients more extensively than necessary (Gosden et al. 2001). At the same time, the lack of information makes it difficult or impossible for patients to discover such behavior. Thus, because of informational asymmetries, the demand for health care, which should be determined by the (informed) demander in a functioning market, can turn into a supplier-induced demand (Carlsen and Grytten 1998, 2000).

4 Under fee-for-service remuneration schemes, providers collect revenue respective to the individual services they provide; therefore, if fees exeed costs for services, the providers earn more as they provide more services (see Glied, S. 2000. "Manged Care." In *Handbook of Health Economics*, edited by A. J. Culyer and J. P. Newhouse, pp. 707-53 Amsterdam: Elsevier.

Even more intensive use of healthcare services is induced if many healthcare providers in a limited area coexist with large insurance coverage for the healthcare costs. If patients do not have to face the financial consequences of their medical treatments in their private budgets, neither willingness nor the ability to pay sets a financial limit on their health service consumption.

Demand-side policies, such as providing consumers with as much relevant information as possible try to reduce the gaps in interests between healthcare providers and patients, are plausible solutions to this problem. Different supply-side policies and alternative funding schemes are also conceivable. One such supply-side policy is an instrument called "*agency*" (Hurley 2000), an attempt to make the provider act more in the interest of the patient. One can try to reach this goal through a dual-faceted strategy based on creating a professional culture that focuses more on the interests of the patients and of simultaneously reducing the competitive market pressures on the providers.

Better balance between the interests of service providers and patients can also be encouraged with particular funding schemes. A good example of this is the remuneration of providers with *capitation*[5]. In these schemes, service providers dispose of global budgets for every patient, which can depend in size on the patients' diagnosis. In comparison to fee-for-service remuneration schemes, the incentives for the service providers are turned around. A limited budget causes the service provider to become financially advantaged when he or she manages to bring back the patient to good health as quickly and efficiently as possible.

Insured patients, however, might still be interested in getting more than the optimal level of health care (where marginal costs equalize marginal benefits). To counter this patient-side incentive to a potential overtreatment, the system should be designed in terms of a *double agency* (Blomqvist 1991). Here, doctors do not act exclusively as agents for their patients but instead incorporate the interests of third party payers—normally, insurance companies. In such a role of being a "double agent," a medical doctor is forced to balance the conflicting interests of the insurance companies and the patients.

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5 "Capitation" can be defined as the amount of health service funding to be assigned to a person with certain characteristics for the service in question and the time period in question, subject to any overall budget constraints (Rice, N. and P. Smith. 1999. "Approaches to Capitation and Risk Adjustment in Health Care: An International Survey." *Centre for Health Economics.* York: University of York.).

A major concern related to flat rate funding schemes like capitation involves quality of care. A functioning healthcare market would include competition on the basis of quality. If patients would be able to assess the quality of their treatments effectively—which is difficult because of the aforementioned information asymmetries and also because the quality perceived by the patient can significantly differ from objective quality—providers delivering poor quality care would be eliminated through the patients' choice.

There also exist important informational asymmetries in the *insurance market* for healthcare services. This point is discussed with respect to the fourth characteristic of health care as an economic commodity: the notion of *uncertainties*. Uncertainties are an important issue in the healthcare sector because incidences of health problems often occur purely by chance for individuals. In many cases, these unforeseeable incidents occur in unexpected and irregular ways during peoples' lives. Moreover, if a health problem actually occurs, it is often unclear whether the therapeutic measures applied against it are really effective.

Uncertainties are the reason why *insurance markets* have replaced exclusively individual funding of healthcare services. Health insurance programs pool the individually unbearable financial consequences of health risks in insurance communities and create welfare gains for the society and the individuals. However, insurance markets are also confronted with a variety of conceptual problems. The most prominent of these challenges are called "adverse selection" and "moral hazard," two phenomena that are briefly described in the following paragraphs.

In the health insurance sector, *adverse selection* occurs when health insurance policyholders have better access to information about their own health status and health risks than do the insurance companies (Rothschild and Stiglitz 1976). In unregulated insurance markets, policyholders who estimate themselves as good risks (i.e., believe themselves to have a small chance of falling ill) are more likely to withdraw from the insurance than those who estimate themselves as bad risks. As a consequence of this behavior, the insurance companies tend to underestimate the average risk of their insurance collectives falling ill.

The result of this underestimation is that such insurers register losses in the corresponding business period. Therefore, in the next period, these insurers will have to increase their premiums in order to counter the losses. The consequence of higher premiums is a new withdrawal of the next segment of good risks, and the premiums must be raised again in the following period. This process continues and demonstrates how adverse selection can bring major instability to health insurance markets. In extreme cases, adverse selection can even cause a collapse of such markets, and no more insurance policies are supplied. The most effective remedy to counter adverse selection and its consequences is to establish a compulsory insurance for the entire population without a possibility of individual withdrawal.

Moral hazard, however, refers to the incitement for *insured* persons to take less care to avoid or limit illnesses or injuries than a person without health insurance. This phenomenon occurs because insured persons do not have to bear the financial consequences of their health problems directly. This behavior is called *moral hazard ex ante*. Moreover, the aforementioned incentives for *insured* patients to demand treatments that are too numerous or too expensive are called *hazard ex post* by health economists (Hurley 2000; Pauly 1974).

Different instruments were developed for health insurance markets to limit such problems caused by moral hazard. The most important preventive measures against moral hazard ex ante are different forms of deductibles or co-payments. Possible countermeasures against moral hazard ex post are (again) the different forms co-payments by the patients and the remuneration of providers with capitation schemes mentioned above.

Another group of measures relies more on the introduction of control mechanisms concerning patients and providers in insurance contracts and their achievement by the insurance companies themselves. From a theoretic point of view, the establishment of appropriate incentive systems—double agency and different forms of deductibles or co-payments to limit potential overuse by patients and capitation to limit potential overtreatment by providers, having been mentioned as possible instruments for this purpose above—seems more efficient than attempting to remove informational asymmetries by administrative controls with high costs of searching for information and of monitoring its appropriate application.

1.3 The question of regionally varying healthcare costs

The analysis of national or regional healthcare costs and utilization differences has a long tradition in health economics. For four decades, researchers have employed a large variety of models, methods, and techniques to explain the different levels and trends in healthcare utilization and costs in Western countries. However, as will be argued when discussing the results of the literature review of Chapter 3, many of the conceptual difficulties of the macroeconomic analysis of healthcare expenditures are not yet resolved (Gerdtham and Jönsson 2000). To date, the scientific description of and explanation for the levels and trends observed in healthcare utilization and costs have always strongly relied on the intuition and experience of the researchers and the availability of statistical data (Martin Martin, Lopez del Amo Gonzalez, and Cano Garcia 2011).

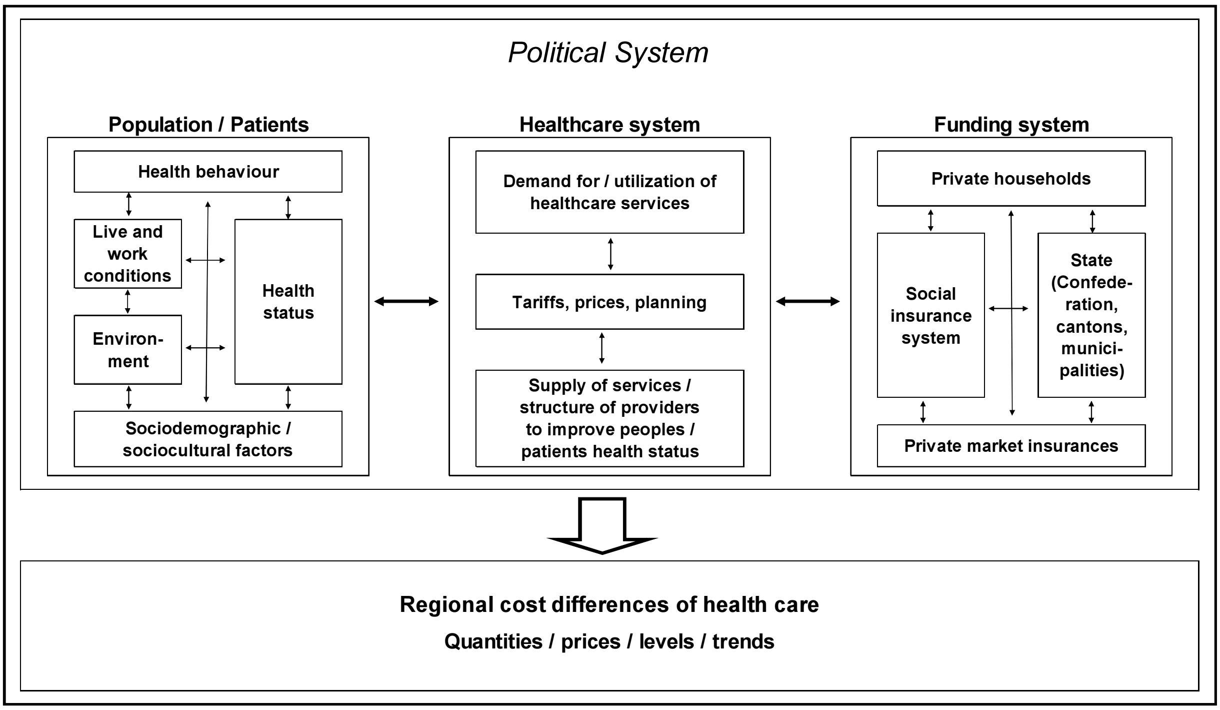
In one of the first important studies about varying national levels of healthcare costs (Buchanan 1966), there was a particular interest in the question of how much state intervention in the imperfect market for health care results in an optimal outcome for the population in the sense of allocative efficiency (Leu 1986). The definition and measurement of such an optimal outcome—the output of good quality, well-distributed health services that are efficiently produced and consumed in comparison with other social demand such as education and security—is one of the great challenges facing economic research on healthcare expenses and their disparities.

The employed and consumed *inputs* for the production of health normally can be described and quantified by cost, volume, and price indicators. However, the difficulties facing the definition and quantification of *utility* or *outcome* of healthcare services are far from being mastered (Kelley and Hurst 2006; Olmsted Teisberg 2008). Without progress in solving these fundamental problems, it remains impossible to evaluate the technical and productive efficiencies of healthcare production and the allocative efficiency of a certain level of healthcare expenditure in a given country or region.

These questions encourage burgeoning political interest in a market that is strongly regulated by public authorities and broadly financed by mandatory health insurance (MHI) premiums and state subsidies, at least in the cases of Switzerland and many other Western countries. This political interest has clearly grown over the last 20 years because of the strong or even disproportionate increase in healthcare expenses observed in all Western countries (see Section 2.2). Health economists in the field try to find more evidence for the factors associated with this constant growth by comparing different countries or regions with respect to their levels of and trends in healthcare costs. The major hope is to detect allocative, distributive or productive inefficiencies in the healthcare sector and to derive evidence-based recommendations for cost-containment strategies for politicians.

As mentioned previously, it might actually not be enough to examine a healthcare delivery system and how it functions in an isolated manner. Rather, it would be necessary to execute such research in a larger societal context. Figure 1 illustrates how such an attempt could be made by inserting the healthcare system into the framework characterizing the political system. The political system sets up the rules for how decisions are made in the democratic process. However, it can also stand for the types of priorities that are pursued by the people and their policy makers according to the actual balance of power.

Figure 1: Factors of influence on regional differences of healthcare costs in Switzerland



Source: (Camenzind 2008), S. 37.

The interplay of all of these elements results in a certain volume of consumption and expenses in the healthcare system of a country or a region. Moreover, such regional differences between costs are divisible into three main components: the quantities, the prices, and the particular mix of health services consumed (i.e., “medical practice”) (OECD 2011b). Therefore, it is possible that one, two, or all three of these components, which can be influenced by completely different factors, are responsible for varying levels of and trends in healthcare costs. Finally, different factors of influence again can be responsible for high relative levels or a relative fast growth of healthcare costs and its three components.

In summary, important challenges in the field of empirical analysis of regional cost and utilization differences in the health sector—problems that are faced by many other fields of applied research as well—are the difficulties that face setting up a comprehensive macroeconomic base, different problems concerning the conception, definition, and measurement of the utility of health care, economic particularities of the commodity of health care, imperfections in health care and health insurance markets, and the enormous complexity and the broad interdependence of the healthcare system with other sectors of the society. This list can be completed by referring to the data situation that is often insufficient.

2 Swiss healthcare system

2.1 Structure of the Swiss healthcare system

2.1.1 Political and organizational structure

As of 2009, the population of Switzerland consists of 7.8 million people living in a total area of 41,000 km^2. The native language of two-thirds of the population is German; for 20 percent, it is French; and the remaining population speaks Italian and Rhaeto-Romanic or another, non-official language, such as Spanish, Portuguese, Turkish, Albanian, or Serbo-Croatian.

Swiss government is administered at three statutory levels: the central government ("Confederation"), the cantons (26 in number), and the municipalities (2,600 in number) (FSO 2011b). The 26 Swiss cantons greatly differ in area, number of inhabitants, and socioeconomic situation[6]. With regard to population differences, for example, the cantons range from 16,000 inhabitants in Appenzell Innerhoden (AI; see Figure 2) to 1.351 million in Zurich (ZH).

Basically, Switzerland's healthcare system is organized in accordance with liberal and free-market principles. The state's responsibility toward this system primarily rests in its guarantee of a political structure in which the actors in the healthcare system operate. However, as in other societal domains, such as education, security or defense, the special character of health and health care and the imperfections in healthcare service and health insurance markets (see Chapter 1) result in more interventions being made by the state.

Consequently, the Swiss healthcare system is not accurately characterized as operating within the "free market." Instead, this system is better described in terms of "regulated competition" (Enthoven 1988). This concept reflects competition between market players wherever such competition seems to generate better outcomes than regulation by state authorities. In the Swiss healthcare system, competition is particularly relevant for mandatory health insurance (MHI) companies and for MHI providers, just as it is for physicians in private practices and for acute care hospitals within cantons[7] (Hammer, Peter, and Trageser 2008).

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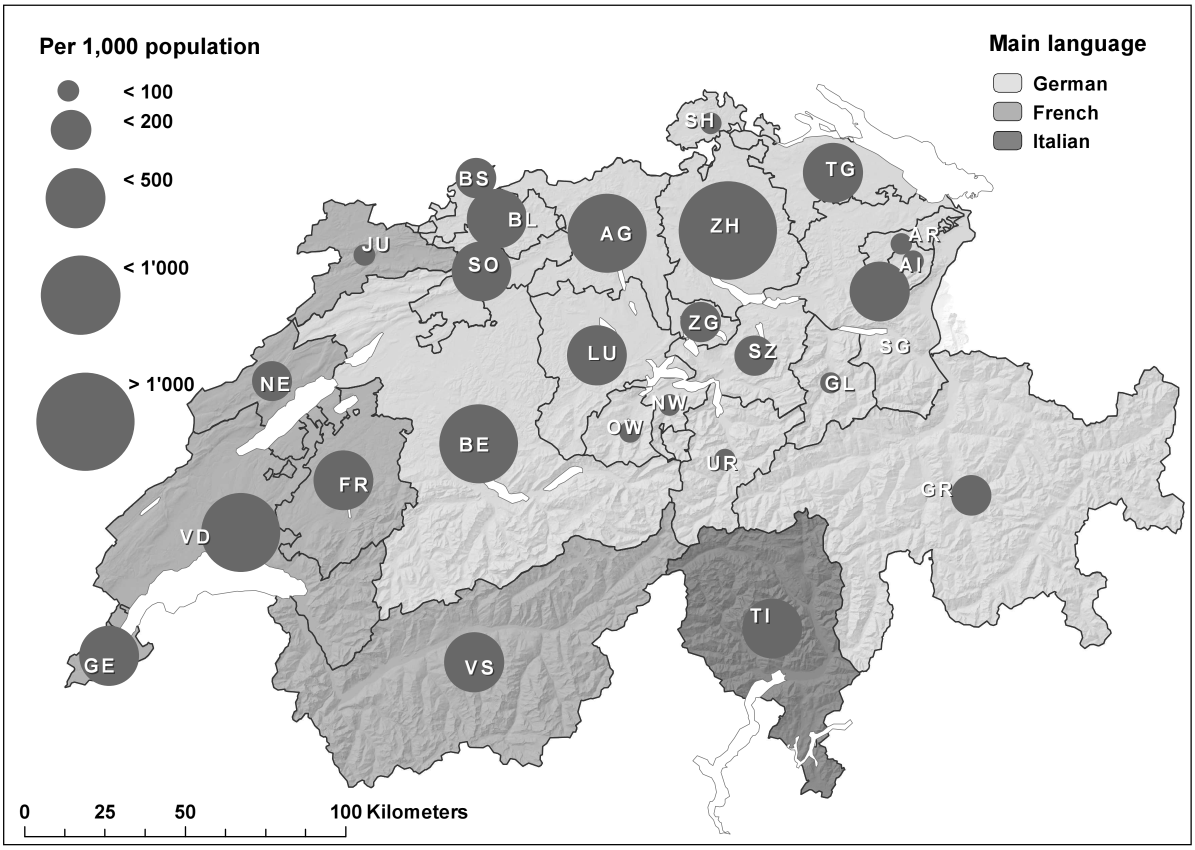
[6] Because of the important role played by the Swiss cantons in the country's healthcare system, their great heterogenity is emphasized.

[7] Without special supplementary insurance, it was impossible to choose hospitalization outside one's own residential canton until 2012.

Figure 2: Population sizes and main languages of Swiss cantons[1)], per 1,000 population



1) Aargau (AG), Appenzell Ausserrhoden (AR), Appenzell Innerrhoden (AI), Basel-Stadt (BS), Basel-Landschaft (BL), Bern (BE), Fribourg (FR), Geneva (GE), Glarus (GL), Graubünden (GR), Jura (JU), Lucerne (LU), Neuchâtel (NE), Nidwalden (NW), Obwalden (OW), Schaffhausen (SH), Schwyz (SZ), Solothurn (SO), St. Gallen (SG), Thurgau (TG), Ticino (TI), Uri (UR), Valais (VS), Vaud (VD), Zug (ZG), Zurich (ZH).

Source: (FSO 2011a), personal representation.

Regulatory responsibility and public funding of healthcare provisioning are shared on three state levels in Switzerland: the Confederation, cantons, and municipalities. However, the Swiss cantons are principally responsible for the development and the implementation of health policy. In particular, the cantons have the mission to guarantee a sufficient supply of inpatient and outpatient services for their populations. They also contribute the largest portion of health-related state payments to inpatient hospitals and to nursing homes[8].

8 Seventy-nine percent of all direct state payments (by cantons and municipalities—the Confederation does not directly subsidize healthcare providers in Switzerland) were *cantonal* subsidies to inpatient healthcare providers (i.e., acute care hospitals and nursing homes). This share ranged from 62 percent (canton ZH) to 92

Otherwise, the responsibility for healthcare policy is explicitly ascribed to the Confederation. The central government of Switzerland has a legislative function concerning MHI and a supervisory function concerning the country's 81 MHI companies[9]. Moreover, the Confederation is responsible for maintaining the educational standards and training of all types of healthcare personnel and is charged with the health protection of the population, the surveillance and management of infectious diseases, and the promotion of health sciences and health research.

The most important role adopted by municipalities is to perform the tasks that are handed over to them by the cantons. In most cases, these tasks concern the administration and funding of providers either for long-term outpatient care (called "Spitex" in Switzerland) or for long-term inpatient care (i.e., nursing homes).

This system's incorporation of regulated competition and a strong federalist structure highlights the two main characteristics of the Swiss healthcare system. The system of regulated competition in Swiss health care offers fertile ground for political discussion. Questions often arise about the optimal delimitation between free-market policies and state regulation for the different elements of the healthcare system. One example of such discussion is whether MHI insurers should remain obligated to refund services in the MHI benefit basket produced by *all* healthcare providers (i.e., the obligation of contracting).

A qualitative assessment of the efficiency and effectiveness of such healthcare system elements might be performed by comparing them with the "ideal" model of regulated competition in health care (Enthoven 1988). Such a comparison would require assessing technical and productive efficiencies on the level of the individual actor or the individual institution as well as on the level of the individual medical good or service (i.e., outcome or output with respect to quality). Important reasons for there being only *modest* progress in these tasks are the lack of data, methodological difficulties and opposing political interests. It is highly probable that gains in technical and productive efficiencies are possible on these individual levels. Inefficiencies are strongly suspected to be related to the following important

percent (cantons SO, GL, SH, and AR), see FSO. 2012f. "Nettofinanzbedarf der Kantone und der Gemeinden im Gesundheitswesen." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).

9 In 2009, 81 insurance companies were active in the Swiss MHI (FOPH. 2011a. "Statistik der obligatorischen Krankenpflegeversicherung 2009." *Statistiken zur Krankenversicherung.* Bern: Swiss Federal Office of Public Health (FOPH).

system elements in Swiss health care (Meyer 2008): the aforementioned obligation of contracting between MHI insurers and service providers, the prohibition of MHI contracts to include special insurance models that are effective for longer than one year, the prohibition of annual deductibles in MHI being related to the income (or even the wealth) of the insured persons[10], the prohibition of profit-making for MHI companies, the incomplete risk equalization system[11] in MHI, the extensive subsidization of hospitals for MHI patients by the cantons, and the multiple and sometimes conflicting functions of cantons when operating, financing, and supervising inpatient acute care hospitals.

There also are intense political discussions about the second feature specific to the Swiss healthcare system: its strong federalist structure (Achtermann and Berset 2006). A federalist healthcare system has the advantage that its decision makers are—with respect to geography and common experience—closer to the local population and the local healthcare providers. This characteristic increases the probability that the responsible authorities will directly consider the expectations and needs of the local inhabitants and providers (Haari et al. 2002). In general, this behavior is regarded as an advantage for a culturally and topographically heterogeneous country like Switzerland (see Figure 2). This “proximity” is also one of the important contributors to the nearly universal satisfaction with the healthcare system repeatedly reported in several surveys (Sturny and Camenzind 2011).

However, the federalist structure leads to greater complexity and reduces the potential for good governance in the Swiss healthcare system (OECD/WHO 2006, 2011). The coordination of the system as a whole—e.g., achieving consensus about how to concentrate the expensive and (from a medical point of view) impractical oversupply of several highly specialized medical services, such as organ transplantation, at only few hospitals across the country—is more difficult. A certain amount of incoherence, redundancy, and obstruction in healthcare regulation, particularly beyond the cantonal level, must be accepted. The first paper presented in Part II of this document includes results that better support the idea of smaller healthcare areas having lower costs than larger regions.

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10 The prohibition of annual deductibles being related to income or wealth might be more problematic with respect to equity issues in financing MHI than to problems of inefficiency.

11 The risk equalization system of the Swiss MHI compensates for several dimensions: the canton of residence, gender and age group of policyholders. Since 2012, a new element—health status, operationalized as having had hospital or nursing home stays of more than 3 days in the previous year—has improved the funtioning of the system.

2.1.2 Mechanisms of healthcare funding

From a macroeconomic perspective, the funding of the Swiss healthcare system of CHF (Swiss francs) 61.0 billion (as of 2009) falls to households, the state and firms. Within this framework, households bear the largest burden of the national healthcare costs at CHF 44.0 billion (72.1 percent, see Table 1). Households pay premiums for mandatory (MHI) and voluntary health insurance (VHI) (CHF 26.8 billion, 43.9 percent)[12], raise the co-payments for both types of health insurance (CHF 3.4 billion, 5.6 percent), and finance out-of-pocket expenses for dental care, long-term care and some other services (CHF 13.8 billion, 22.6 percent).

Table 1: Funding of Swiss health care from a macroeconomic perspective, 2009, in billions of CHF and in percentages of total costs

2009	in billion CHF	in % of total costs
Households	**40.5**	**66.3%**
Health insurance premiums	23.2	38.1%
Cost-sharing health insurances	3.4	5.6%
Out-of-pocket and other funds	13.8	22.6%
State	**17.2**	**28.2%**
Subsidies to providers	10.9	17.8%
Premium subsidies to households	3.5	5.8%
Health promotion and prevention, other social security, administration	2.8	4.6%
Firms	**3.3**	**5.5%**
Total costs	**61.0**	**100.0%**

Source: (FSO 2012a), calculations by the author.

[12] The individual and income-based subsidies of CHF 3.5 billion that help cover MHI premiums are included in this number.

The state (i.e., Confederation, cantons, and municipalities) funded CHF 13.5 billion or 22.1 percent of the nation's total healthcare expenditures in 2009. CHF 10.9 billion (17.8 percent) were subsidies to healthcare providers (acute care hospitals and nursing homes in particular). The other CHF 2.6 billion or 4.3 percent spent by the state were subsidies to other social security insurance programs and expenses for health prevention activities, health promotion activities and system administration.

Swiss business firms co-finance the health-related parts of accident insurance (UV), disability insurance (IV), and the old-age insurance (AHV). The total contributions of business firms amounted to CHF 3.5 billion or 5.7 percent of the total healthcare costs in 2009. This relatively small number points to a peculiarity of the Swiss healthcare system in comparison to other Western countries. Health insurance coverage in Switzerland is largely unlinked to an individual's occupational status; consequently, business firms finance only a relatively small share of healthcare costs. The parties most responsible for Swiss health care are individual persons or individual households, which bear more than 70 percent of healthcare costs in the forms of premiums, co-payments, and out-of-pocket expenditures.

The central element in the Swiss healthcare *funding* system is the program of mandatory health insurance (MHI). MHI places at the entire population's disposal a basic insurance package protecting against the financial consequences of illnesses, accidents[13], and motherhood. Some particular system elements in MHI can be emphasized. One important element is the MHI benefit basket, defined as the list[14] of all treatments that are uniformly remunerated by all MHI insurers. New treatments are only accepted for the MHI benefit basket if the federal admission authority considers them to be medically effective, appropriate, and cost-effective. The difficulties involved in proving the cost-effectiveness of healthcare services and goods have elsewhere been demonstrated in the economic literature (Skinner et al. 2009).

[13] For individuals who are employed, accidents are covered via employment. For non-employed individuals (e.g., children, professionally inactive adults, retired persons), MHI also covers the costs associated with recovery from accidents.

[14] Insurers are obligated to remunerate for all treatments appearing in the benefit basket; in contrast, they are prohibited from remunerating for treatments that are not in the benefit basket.

Another important system element of MHI is the fact that the premiums required by insurers for defined premium regions[15] may, in principal, not vary based on the relative health risks—i.e., gender, age, or health status—of the insured person[16]. The premiums of the insurers can vary only by three age categories[17], by the level of the deductible, and for managed care insurance models. With this premium policy, *solidarity* between men and women, between the young and the old, and between healthy and ill persons is targeted in MHI[18].

Nevertheless, it is still possible that significant premium variations exist between different MHI insurers within a single premium region because the insurers have to calculate premiums with respect to the concrete MHI costs they faced in that region during the previous period. Thus, policyholders can optimize their insurance coverage by changing to an MHI insurer offering a lower premium in this particular region for the coming year. To maintain competition between insurers, MHI companies are obligated by law to accept every request for admission of individuals living in the corresponding premium region. Another technique by which policyholders can optimize annual expenses for MHI is to sign a contract offering a special insurance package with higher deductibles, a bonus system of insurance, or an insurance with a restricted choice of healthcare providers.

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15 For every canton, the federal authorities define a maximum of 3 different premium regions. In the following cantons (see also Figure 3), there is just one premium region: AG, AI, AR, BS, GE, GL, JU, NE, NW, OW, SO, SZ, TG, UR, ZG (FOPH. 2011b. "Prämienregionen in der OKP der Schweiz gültig ab 1.1.2011 bis 31.12.2011." *Statistiken zur Krankenversicherung.* Bern: Federal Office of Public Health (FOPH).

16 In reality, insurers have developed strategies for selecting individuals; for the Swiss case, see Dormont, B., P.-Y. Geoffard, and K. Lamiraud. 2009. "The influence of supplementary health insurance on switching behaviour: evidence from Swiss data." *Health Economics* 18(11): 1339-56, Frank, R. and K. Lamiraud. 2009. "Choice, price competition and complexity in markets for health insurance." *Journal of Economic Behavior & Organization* 71(2): 550-62).

17 Viz., children up to age 18, young adults aged between 19 and 25, and adults older than 25 years.

18 Solidarity is one of the 3 main goals of MHI, in addition to good quality of health care and moderate changes in healthcare costs. To the equalization that occurs across genders, ages and health status can be added a fourth element: equalization between richer (and, on average, healthier) and poorer people. Because MHI premiums are calculated independent of the economic situation of the insured persons, equalization between rich and poor people only takes place in the field of expenses paid by the state for health care (except that, if wealthier individuals pay MHI premiums and are, in fact, healthier, they make less use of the healthcare system and subsidize the care of poorer individuals). These expenses for state subsidies (see Table 2) are imposed through progressive income taxes. To quantify the scale of the redistribution of this mechanism, extensive incidence analyses are necessary (see Crivelli, L. and P. Salari. 2012. "Fiscal federalism and income redistribution through healthcare financing: An empirical analysis for the Swiss cantons." *CEPRA working paper.* Lugano: Center for Economic and Political Research on Aging, Università della Svizzera italiana, Iten, R., A. Vettori, S. Menegale, and J. Trageser. 2009. "Kosten-Wirksamkeit ausgewählter Präventionsmassnahmen in der Schweiz - eine gesundheitsökonomische Untersuchung: Schlussbericht." VIPS. Zürich: INFRAS Forschung und Beratung, Müller, A., T. Schoch, and E. Kraft. 2013 (unpublished). "Umverteilungseffekte in der obligatorischen Krankenversicherung." *Experten-/Forschungsberichte zur Kranken- und Unfallversicherung.* BAG. Bern: ECOPLAN Forschung und Beratung in Wirtschaft und Politik.).

The cost-sharing mechanism in Swiss MHI tries to counter the problems of moral hazard (both ex ante and ex post). The first element of cost-sharing is the deductible. The amount of this deductible is CHF 300 by default, but it can reach CHF 2,500 in favor of a limited premium reduction. Insured persons pay out of pocket for all healthcare goods and services consumed within one year and up to the limits given by this deductible. The second element is the co-payment. MHI policyholders must bear ten percent of the costs that exceed the individual deductible. The maximum amount the insured persons have to pay for co-payment is limited per year to CHF 700 for adults and to CHF 350 for children under 18 years.

One additional important characteristic of MHI is the system of individual premium subsidies. In this context, "individual" means that the system aims to specifically reduce MHI premiums for individuals with limited economic resources. Cantonal authorities define their own models linking income and assets to households' claims to individual premium subsidies. Fifty-one percent (CHF 1.8 billion in 2009) of transferred subsidies devolve from the Confederation budget, and 49 percent (CHF 1.7 billion) devolve from the cantonal budgets. In 2009, 2.3 million persons or 29 percent of the Swiss population received individual MHI premium subsidies (FOPH 2011a). The fact that premium subsidies add up to CHF 3.5 billion (see also Table 1) means that one out of six Swiss francs for MHI premiums in Switzerland is imposed via taxes and five out of six francs are directly paid from private households to MHI companies.

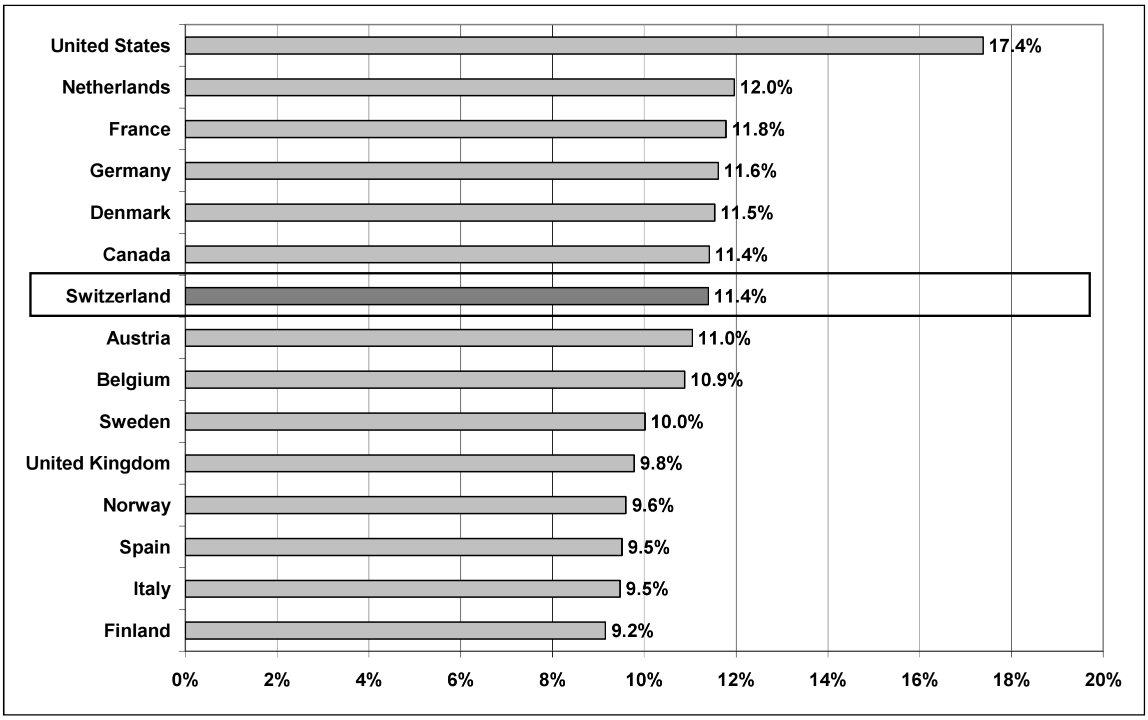
2.2 Swiss healthcare costs compared to selected OECD-member countries

Figure 3 shows the level of healthcare costs in a selection of thirteen Western European OECD-member countries, including Switzerland and two North American OECD-member countries, Canada and the US. The level of healthcare expenditures of these fifteen countries is expressed as a percentage of the annual gross domestic product (GDP) for each country.

The US spent by far the highest share of GDP for health care: 17.4 percent. One major explanation for such high healthcare costs is that the US has unusually high prices for healthcare services compared to other Western countries (Marmor, Oberlander, and Joseph

2009). The level of 17.4 percent of GDP for the US is 6 percentage points more than the corresponding values for Switzerland and Canada (11.4 percent). Nevertheless, these latter two countries still find themselves in the group of most “expensive” countries, together with the Netherlands (12.0 percent), France (11.8 percent), Germany (11.6 percent), and Denmark (11.5 percent).

Figure 3: Levels of healthcare costs in 15 selected OECD-member countries, 2009, as percentages of GDP

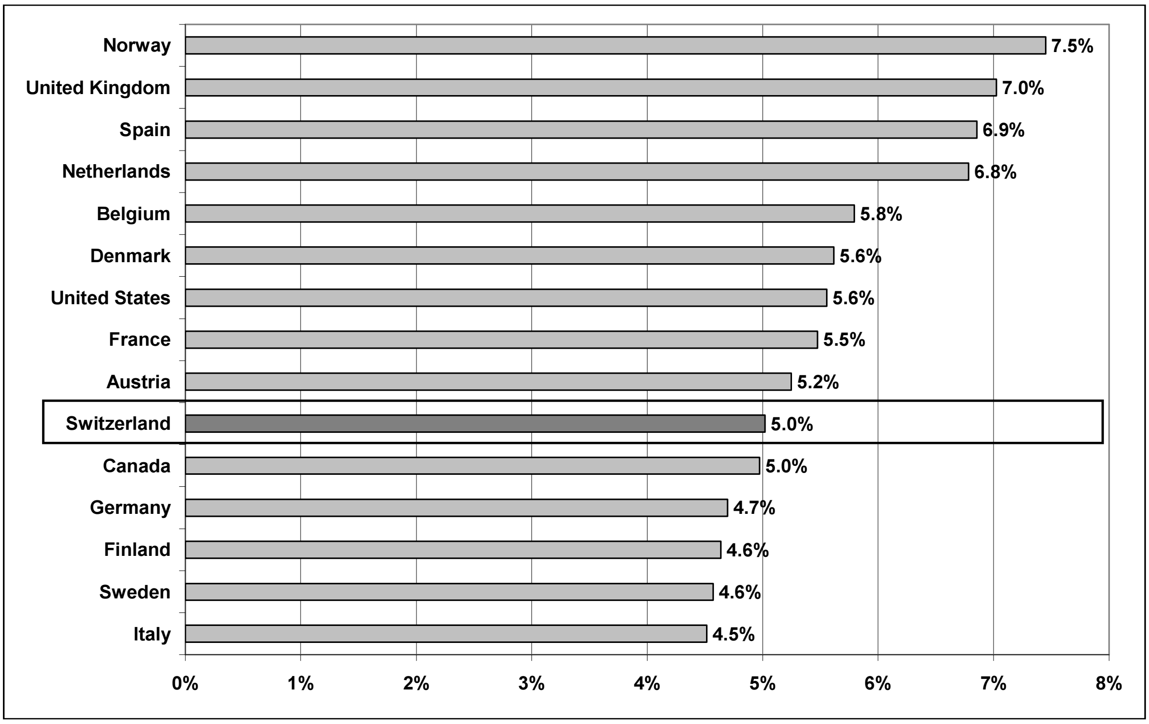


Source: (OECD 2011a); as of 7/13/2011, calculations by the author.

The other Western European countries spent 11.0 percent (Austria) or less of their GDP on health care in 2009: Finland: 9.2 percent; Italy: 9.5 percent; Spain: 9.5 percent; Norway: 9.6 percent; the United Kingdom: 9.8 percent; Sweden: 10.0 percent; and Belgium: 10.9 percent. This indicator depends on two economic indicators: the absolute value of the countries’ expenses for health care and the countries’ economic prosperity, expressed in terms of GDP. Switzerland’s somewhat larger growth of GDP over the last few years resulted in “losing” the former second position behind the US in the above ranking.

The next Figure—Figure 4—which contains the same fifteen countries as Figure 3, shows that the average annual growth rate of healthcare expenditures during the last 20 years ranges between 7.5 percent (Norway) and 4.5 percent (Italy). Figure 4 also confirms that—compared to the other selected countries—Switzerland showed an *average* growth of its total healthcare costs over the last 20 years. The average annual growth of Swiss healthcare expenditures—calculated in US dollars and adjusted for purchasing power parity—was 5.0 percent, the same rate experienced by Canada. Only Italy (4.5 percent), Sweden (4.6 percent), Finland (4.6 percent), and Germany (4.7 percent) showed smaller average growth rates of healthcare expenses over the observed period.

Figure 4: Annual growth rate[1)] of healthcare costs: 15 selected OECD-member countries, 1990-2009, in percentages



Source: (OECD 2011a); as of 7/13/2011, calculations by the author.

[1)] Average annual growth at current prices and adjusted for purchasing power parity (PPP) per capita, in %.

These international comparisons prove that neither the level (as shares of GDP) nor the growth of total Swiss healthcare costs has been truly exceptional. Instead, the changes experienced by Switzerland reflect a phenomenon experienced by all Western countries over the last twenty years and seems to be more-or-less independent of the concrete organizational or institutional structure of the country's healthcare system[19]. With average annual growth rates for healthcare expenditures between 4.5 percent and 7.5 percent over the last two decades, almost all of the observed Western countries are approaching or have passed the ten percent mark for healthcare's share of GDP. Topping the mark of 12 percent seems, for most of these countries, only a question of time.

Projections in general and predictions of the future development of healthcare costs in particular face manifold difficulties. Without further exploring these problems, the results of two newer studies for Switzerland (Colombier 2012; Vuilleumier, Pellegrini, and Jeanrenaud 2007) are cited. The earlier of the two studies (Vuilleumier et al. 2007) offers estimates of total Swiss healthcare expenditures from 2004 to 2030. In one scenario, assuming a certain improvement in health status development because of medical progress and a healthier lifestyle in the population, Swiss healthcare costs are expected to go up from 11.4[20] percent to 15.4 percent (an increase of 4.0 percentage points) of the GDP by 2030. In the other scenario, where an aging population[21] leads to an increase in the average morbidity, healthcare costs could rise to a share of 16.7 percent of the GDP by 2030—an increase of 5.3 percentage points.

The study by Colombier (2012) covers an even longer time period: from 2009 to 2060. The share of GDP, starting at 11.3 percent in 2009[22], is anticipated to increase to 15.8 percent (plus 4.5 percentage points) by 2060 in the reference scenario. Seven additional variants to the reference scenario are estimated. The seven alternative scenarios vary in their assumptions concerning the future morbidity of the population, future developments in the labor market for healthcare personnel, future developments and consequences of international migration,

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[19] The OECD proposes 6 groups of countries sharing broadly similar institutions: 1. Gemany, Netherlands, Switzerland; 2. Belgium, Canada, France; 3. Austria; 4. Sweden; 5. Denmark, Finland, Spain; 6. Italy, Norway, the United Kingdom. Not grouped in the OECD-paper was the United States of America (see OECD. 2010. "Health care systems: Getting more value for money." *OECD Economics Department Policy Notes.* pp. 1-11. Paris.)

[20] The revised statistics of the FSO indicate a 10.2 percent share of GDP in 2007, 10.3 percent in 2008, 11.0 percent in 2009, and 10.9 percent in 2010 (FSO. 2013b. "Kosten und Finanzierung des Gesundheitswesens (provisorisch) 2011." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).)

[21] The two important causes for the aging population observed in Western societies are the following. First, a population becomes older if its life expectancy increases. Second, aging of the population results from large age cohorts (e.g., the "baby boomer generation") becoming older and being followed by smaller cohorts of young people (i.e., a shrinking society in the long run).

[22] See footnote 20.

and political developments concerning the future relationships to the European Union. Without going into the study's details, the study contains no scenario projecting a share of healthcare costs as a proportion of GDP less than 13.8 percent (plus 2.6 percentage points) or more than 17.1 percent (plus 5.9 percentage points). Compared to (Vuilleumier et al. 2007), the work of (Colombier 2012) uses clearly more optimistic assumptions. Even in the most pessimistic scenario (17.1 percent in 2060), the projection for 2030 is 13.5 percent, 3 percentage points less than in Vuilleumier and colleagues' work (Vuilleumier et al. 2007).

2.3 Sectional and regional structures of Swiss healthcare costs

2.3.1 The sectional structure of healthcare costs in Switzerland

Table 2: The costs and financing of health care by service providers and direct payers, 2009, in billions of CHF

2009		Direct payers					Total	
Service providers		State	Social insurance (without MHI)	Mandatory health insurance	Private health insurance	Private households and others	in billion CHF	in percent of Total
Out-patient care (without hospitals)		1.0	0.9	7.6	1.7	7.4	18.6	30.5%
Hospitals outpatient		0.0	0.3	3.0	0.0	1.2	4.4	7.3%
Hospitals inpatient		7.8	1.0	5.2	2.3	1.0	17.3	28.3%
Nursing homes		2.1	0.1	1.6	0.0	6.7	10.5	17.2%
Retail trade		0.0	0.4	3.0	0.4	1.6	5.5	9.0%
State		0.9	0.0	0.0	0.0	0.5	1.4	2.4%
Health insurers		0.0	0.6	1.0	1.0	0.0	2.6	4.3%
Non-profit organizations		0.0	0.2	0.0	0.0	0.5	0.7	1.1%
Total	in billion CHF	11.8	3.5	21.4	5.4	18.9	61.0	100.0%
	in percent of Total	19.4%	5.8%	35.1%	8.8%	31.0%	100.0%	-

Source: (FSO 2012a), calculations by the author.

Table 2 presents the costs financed by direct payers cross-referenced against the costs connected to various service providers for health care in Switzerland in 2009. Concerning direct payers, CHF 36.7 billion or 60.2 percent of the total of CHF 61.0 billion accounted for "socialized" healthcare costs (Crivelli et al. 2008): in other words, the costs funded by mandatory health insurance (MHI, CHF 21.4 billion, 35.1 percent), by state subsidies to healthcare providers (CHF 11.8 billion, 19.4 percent)[23], and by other social insurance programs (without MHI, CHF 3.5 billion, 5.8 percent)[24]. The other CHF 24.3 billion or 39.8 percent were "free market" expenditures of private households (CHF 18.9 billion, 31.0 percent) and of private health insurers (CHF 5.4 billion, 8.8 percent).

Concerning healthcare service providers, outpatient care (excluding outpatient hospitals) was responsible for CHF 18.6 billion or 30.5 percent of the total healthcare costs. Inpatient and outpatient hospitals accounted for CHF 21.7 billion or 35.6 percent of all healthcare expenditures, whereas nursing homes accounted for CHF 10.5 billion or 17.2 percent and retail trade (in drugs and medical aids) accounted for CHF 5.5 billion or 9.0 percent of the total health costs. The remaining expenditures were administrative costs and expenditures for prevention and health promotion by the state (CHF 1.4 billion, 2.4 percent) and administrative costs of the social and private health insurance companies (CHF 2.6 billion, 4.3 percent).

The cross-tabulation of direct payers and health service providers in Table 2 allows a few more features of the Swiss healthcare system to be highlighted. The importance of the aforementioned cantonal subsidies to inpatient hospitals (CHF 7.8 billion) becomes obvious. Compared to that figure, the subsidies paid for long-term inpatient care (i.e., nursing homes) appear modest. The municipalities finance a large share of these CHF 2.1 billion nursing home subsidies.

MHI is most important as direct payer for inpatient and outpatient hospital healthcare services (CHF 8.2 billion) and outpatient healthcare services (CHF 7.4 billion, here without outpatient hospitals). A large part of the latter is spent on general practitioners and specialists in private practices. Retail trade, totaling CHF 3.0 billion, accounts for a relatively smaller share of costs associated with Swiss MHI; the same is true for nursing homes, with "only" CHF 1.6 billion financed by MHI. State subsidies (CHF 2.1 billion) and out-of-pocket funding by private households (CHF 6.7 billion) are more important for this service than is MHI. The

23 This number includes CHF 0.9 billion in *adminstration costs* for the state. However, the state subsidies concerning the *individual premium subsidy* scheme for MHI (3.4 billion CHF, 2009) are not visible in this CHF 11.8 billion. The latter are *direct payments* of the state to healthcare providers.

24 These are the health-related parts of accident insurance (UVG), disability insurance (IV), old-age insurance (AHV) and military insurance (MV).

CHF 6.7 billion spent by private households represents the lion's share of long-term inpatient care in Switzerland—the costs for accommodation and assistance in nursing homes—that are not covered by the social health insurance system (see Chapter 5).

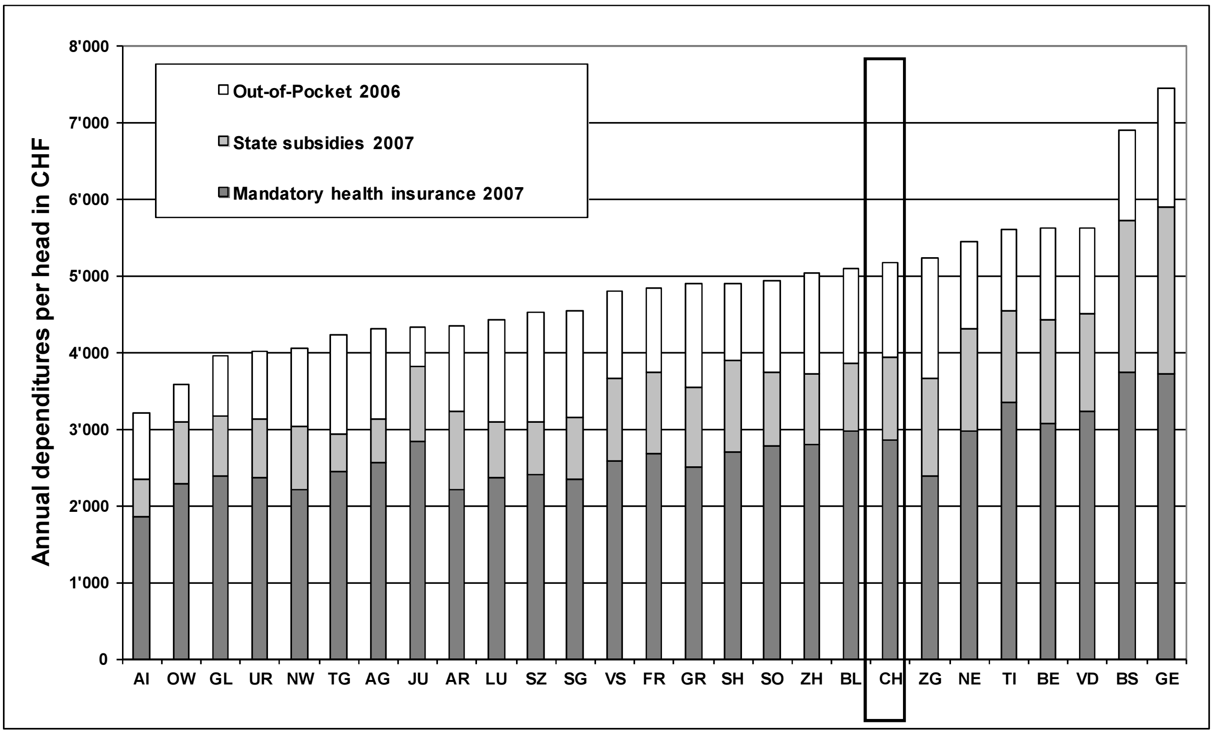
Notable among the figures for private households are the high out-of-pocket expenditures for outpatient care (CHF 7.4 billion). This large number is the result of dental care not being covered by MHI or other social insurance in Switzerland. Almost half of this CHF 7.4 billion—approximately CHF 3.2 billion (Weber 2010)—is spent for dental care services. The other half of these out-of-pocket expenditures goes to outpatient providers producing services that are not included in the MHI benefit basket. One example of this is psychotherapy from non-medical professionals (i.e., psychologists). Such psychotherapy is only covered when administered by a qualified specialist (i.e., a qualified general practitioner or psychiatrist) and performed in the practice rooms of the prescribing specialist (i.e., "delegated" psychotherapy). If these services also are not covered by private insurance, they must be paid out of pocket by the patients.

2.3.2 The regional structure of healthcare costs in Switzerland

The per capita calculations illustrated in Figure 5 show the sum of cantonal expenditures for MHI, state subsidies to providers, and estimations for private households' out-of-pocket expenses. These three sources cover more than 85 percent of all Swiss healthcare costs (MHI: 35.1 percent; state subsidies: 19.4 percent; out-of-pocket expenses: 31.0 percent; see Table 2). No cantonal data are actually available with respect to health-related social insurance expenditures aside from MHI[25] (5.8 percent) and expenses related to voluntary private health insurance (8.8 percent).

[25] These are the health-related parts of accident insurance (UVG), disability insurance (IV), old-age insurance (AHV) and military insurance (MV).

Figure 5: MHI costs, state subsidies, and out-of-pocket expenditures per capita, by canton, 2007, in CHF



Sources: (EFV 2011a; santésuisse 2011a; Stadelmann 2011); calculations by the author; for detailed data: Appendix, Part I, Table 4.

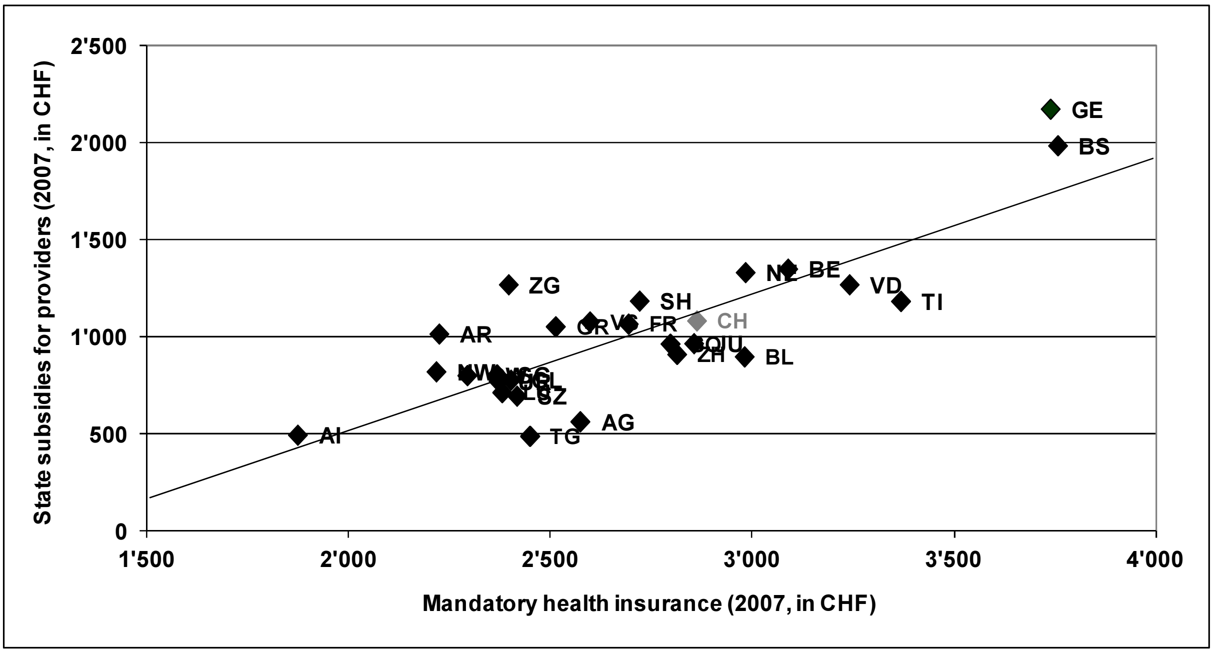
According to Figure 5, approximately CHF 5,200 was spent per capita in 2007 for the three categories of healthcare expenditures in Switzerland (CH). Adding 15 percent for the other social insurance (beside MHI) and the voluntary private health insurance, this value rises to CHF 6,000 per capita annually[26]. The canton with the highest dependitures is Geneva (GE, CHF 7,500); this is approximately two and half times as much per capita as in the cheapest canton, Appenzell Innerrhoden (AI, CHF 3,200). Basel-Stadt (BS) stands out, with costs of CHF 6,900, which is CHF 1,300 more than the cantons of Vaud (VD), Bern (BE), and Ticino (TI), with CHF 5,600 each.

It must be mentioned that all cantonal comparisons are based on *nominal spending* for healthcare goods and services. Therefore, they do not take into account the cantonal or

[26] CHF 6,000 per capita annually, multiplied by 7.6 million inhabitants, results in CHF 45 billion of healthcare costs, whereas the official number provided for total healthcare costs in 2007 is CHF 55 billion. This difference of CHF 10 billion stems mainly from underestimating the average out-of-pocket expenses incurred by private households (approximately CHF 9 billion in Figure 5). Otherwise, the effective average total healthcare costs per Swiss inhabitant shown in Figure 5 would be approximately CHF 7,200.

regional differences in price levels or in costs of living. Unfortunately, no official statistics are available in Switzerland for such average cantonal price levels or average cantonal costs of living[27]. To approximate the magnitude of these differences between cantons, one could compare the regional level of salaries paid in the healthcare branch. The average value of this indicator for Switzerland in 2010 is CHF 5,958 (FSO 2013a) and varies between CHF 5,590 (-6.2 percent less than the national average) for the greater region (and canton) of TI and CHF 6,294 (+5.6 percent) for the greater region (and canton) of ZH[28].

Figure 6: Mandatory health insurance costs and state subsidies for providers per capita, by canton, 2007, in CHF



Source: (EFV 2011a; santésuisse 2011a), calculations by the author; for detailed data: Appendix, Part I, Table 4.

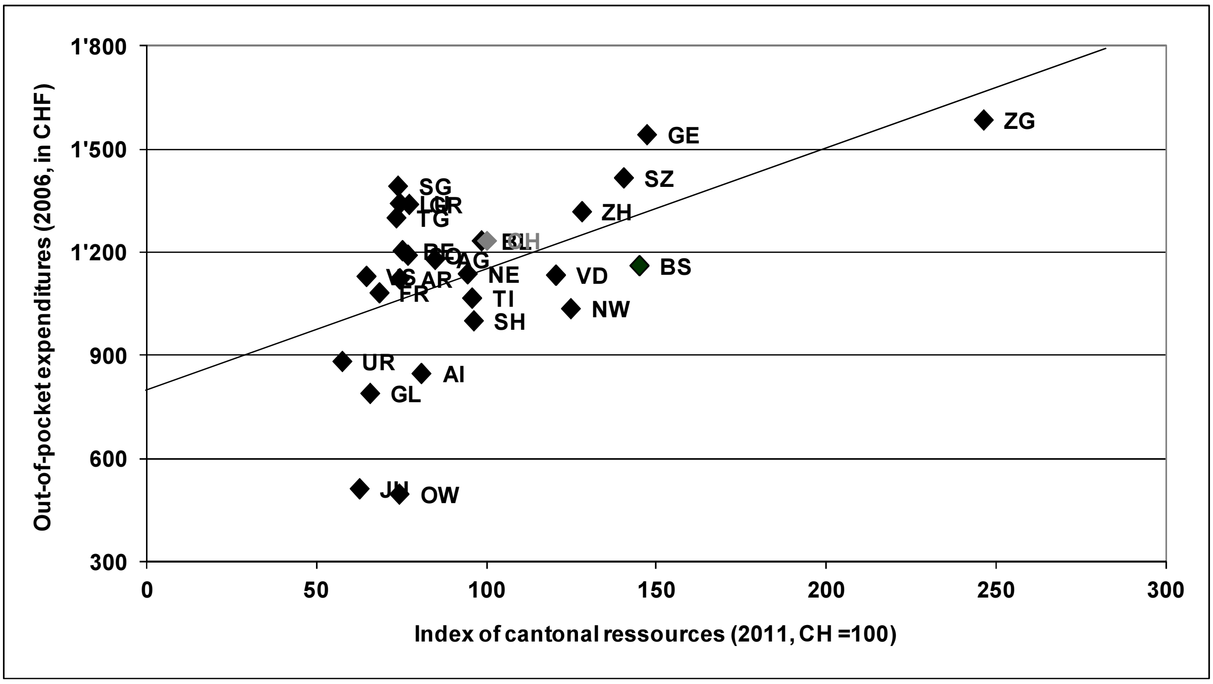
Figure 6 plots the correlation of per capita cantonal MHI expenditures with per capita state subsidies. Calculating a simple correlation coefficient results in a high coefficient of 0.83 for cantonal MHI expenditures and state subsidies. This result is to be expected: the largest portions of state subsidies are contributions by cantons to inpatient hospital care services

27 Three cantons (BS, GE, and ZH) regularly publish general price level indices for their geographical areas.

28 The corresponding values for the other 5 greater regions are as follows: Lake Geneva area: CHF 5,993 (+0.6 percent); Espace Mittelland: CHF 5,884 (-1.2 percent); Northwestern Switzerland: CHF 5,990 (+0.5 percent); Eastern Switzerland: CHF 5,816 (-2.4 percent); Central Switzerland: CHF 5,786 (-2.9 percent).

included in the MHI benefit basket. Thus, if MHI expenditures for this type of treatment are high, the complementary expenditures of the state have to follow.

Figure 7: Index of cantonal resources, 2011, and annual out-of-pocket expenditures per capita, by canton, 2006, in CHF



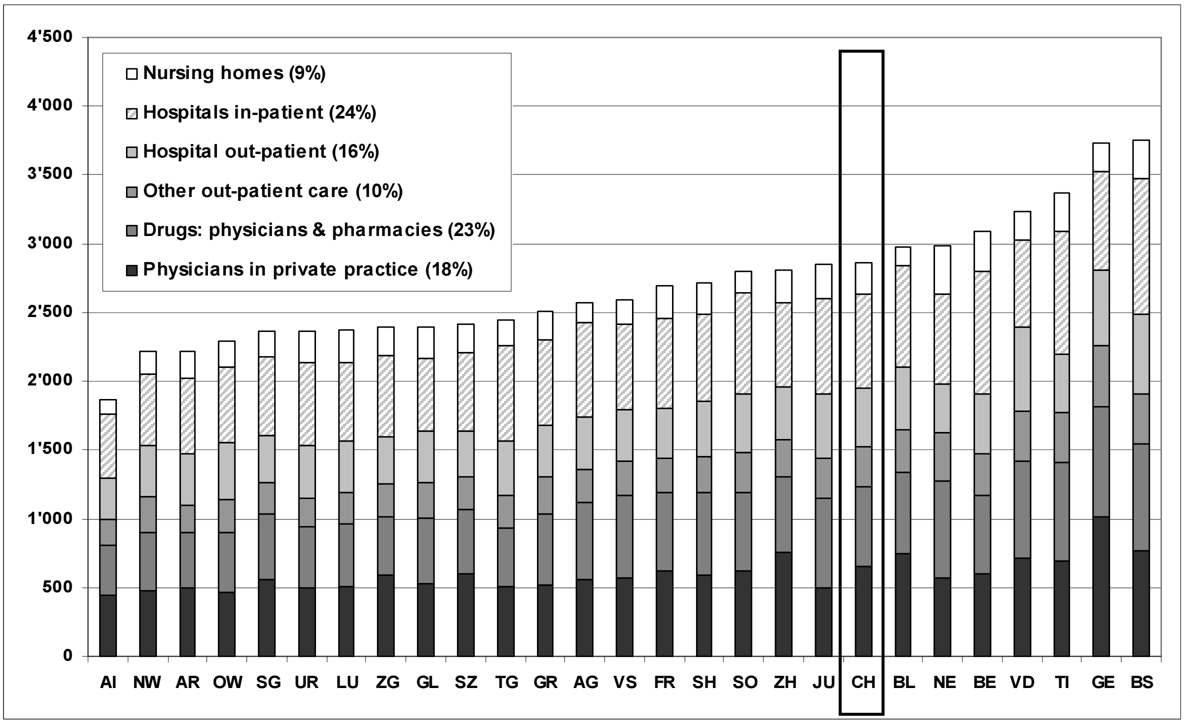
Source: (EFV 2011b; Stadelmann 2011), calculations by the author; for detailed data: Appendix, Part I, Table 4.

The out-of-pocket expenditures are mostly spent on services that are not contained in the MHI benefit basket. Such expenses depend on individual households' resources (after paying MHI premiums, taxes, and other costs of living) and preferences. One can examine this hypothesis by calculating a correlation with a coefficient expressing the financial power of the cantons (e.g., the index of cantonal resources[29]) (EFV 2011b). The resulting correlation index, 0.52, as well as the graphical representation in Figure 7, confirm this hypothesis.

[29] The index of cantonal resources is made up of the taxable income and assets of natural persons and the taxable profits of legal entities. If the cantonal per capita value is compared with the corresponding Swiss average, the result is the resource index. It would make more sense to compare out-of-pocket expenditures with average houshold income per canton. Unfortunately, only cantonal GDP numbers *including* the revenues from *private companies* are published in the official Swiss statistics.

The expenses for MHI-covered services have been a focus of the political discussions on healthcare costs in Switzerland. This focus is not surprising, because the entire population is concerned about MHI. If not paid by premium subsidies, rising MHI costs are directly transmitted to private households in the form of higher MHI premiums. The cantonal differences of MHI costs are presented in more detail.

Figure 8: MHI costs per capita by domains of service providers and cantons, 2007, in CHF



Source: (santésuisse 2011a), calculations by the author; for detailed data, see Appendix. Part I, Table 5.

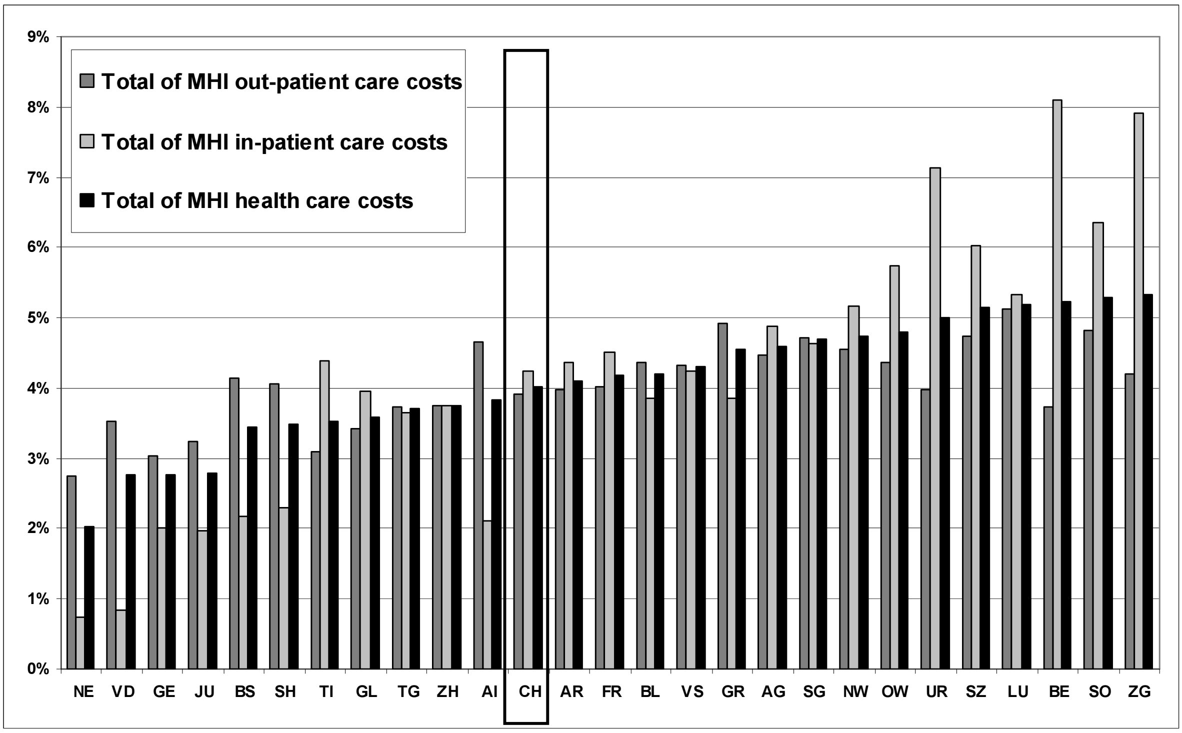
Figure 8 shows 2007 MHI costs per capita for the cantonal populations. The national average (CH) amounts to CHF 2,900 (see also Figure 5). Four categories[30] of outpatient health care—physicians in private practice (18 percent), drugs (23 percent), other outpatient care (Spitex, physiotherapy, etc., 10 percent), and outpatient hospitals (16 percent)—account for two-thirds

[30] Datenpool santésuisse (santésuisse. 2011a. "Datenpool santésuisse: Daten zu Kosten und Inanspruchnahme in der obligatorischen Krankenpflegeversicherung OKP." Solothurn: SASIS AG.) allows the distinction of up to 8 domains of different outpatient services (e.g., general practitioners, specialists, psychiatrists, drugs sold by private practitioners, drugs sold by pharmacies, outpatient long-term care, other outpatient care, outpatient hospitals) and up to 8 domains of different inpatient service providers (central general hospitals, regional general hospitals, psychiatric clinics, rehabilitation clinics, other hospitals, specialized hospitals, nursing homes for elderly and chronically ill, nursing homes for handicapped and others).

(67 percent) of MHI costs on average. One-third (33 percent) are inpatient acute care (24 percent) or long-term inpatient care costs (9 percent).

In addition, Figure 8 shows the cantonal differences of total MHI costs and of the six individual domains of service providers. The most expensive canton BS had MHI costs of CHF 3,800 per cantonal inhabitant in 2007, whereas in the cheapest canton, Appenzell Innerrhoden (AI), these costs amounted to CHF 1,900.[31]

Figure 9: Average annual changes in outpatient, inpatient, and total MHI costs per capita, by canton, 2000-2007, in percent



Source: (santésuisse 2011a), calculations by the author; for detailed data: Appendix, Part I, Table 6.

The levels of cantonal MHI healthcare costs differ significantly; the changes of these costs over time also are not at all uniform. Figure 9 shows the average annual changes in inpatient, outpatient, and total MHI healthcare costs per capita for cantonal inhabitants between 2000 and 2007. The national average (CH) shows 4 percent growth for the three selected indicators.

31 Another possibility for a graphical analysis of the cantonal MHI cost differences concerning expenditures for different service provider domains is shown in Appendix, Part I, Figure 10.

For individual cantons, the annual rise of total MHI costs per capita is between 2 percent in the canton Neuchâtel (NE) and more than 5 percent in the cantons of Zug (ZG), Solothurn (SO), Bern (BE), Schwyz (SZ), and Uri (UR). In all these cantons, faster growing *inpatient* healthcare costs of 6 percent up to 8 percent—together with an average growth of outpatient care at 4 percent—were responsible for this high increase in total MHI costs.

Figure 9 also identifies cantons with reversal tendency. In NE, VD, GE, or Jura (JU) the annual increase of inpatient healthcare costs was rather modest at 1 percent up to 2 percent. Outpatient healthcare costs grew somewhat faster, with increases of 3 percent up to 4 percent being observed in these cantons. The result was an increase in total MHI costs of 2 percent up to 3 percent for NE, VD, GE, or JU in the last decade.

For the interpretation of these results, a technical element known as the *base effect*[32] and real events in cantonal healthcare sectors should be distinguished. A base effect likely occurred for the inpatient healthcare costs of the above-mentioned four cantons with modest percentage increases in total MHI costs (viz., NE, VD, GE, JU). The costs for *inpatient* health care per capita in these four cantons had been among the highest in 2000, whereas the absolute increases of inpatient healthcare costs between 2000 and 2007 were relatively small. The same, but with a reverse sign, was true for the cantons with the largest relative increases per capita of total MHI costs (viz., ZG, SO, BE, SZ, UR). These five cantons had low inpatient healthcare costs per capita in 2000 but faced relatively large absolute inpatient healthcare cost increases between 2000 and 2007.

For *outpatient* healthcare costs, the situation was somewhat different. Again, the costs for outpatient healthcare per inhabitant in 2000 were among the highest for the four cantons with relatively large increases of total MHI costs (NE, VD, GE, JU). Only two of these cantons, JU and NE, enjoyed even modest increases in absolute numbers of per capita outpatient healthcare costs. Conversely, the two cantons of VD and GE experienced quite large absolute increases in outpatient healthcare costs per capita between 2000 and 2007. So here, a base effect seems most likely to be responsible for the modest increases (i.e., less than in the national average) of outpatient healthcare costs for VD and GE.

[32] The fact that a relative growth rate does not only depend on the development of a certain indicator, but also on the level of the starting point of this indicator, is called "base effect".

Moreover, *outpatient* healthcare costs had been rather modest in 2000 in all cantons with large increases of total MHI costs per capita (ZG, SO, BE, SZ, UR). However, only for one canton (SO) was the absolute increase in outpatient costs relatively large (i.e., no important base effect). In the other four cantons (UR, ZG, BE, SZ), the absolute increase in outpatient healthcare costs was less than the national average. In other words, one part of the relatively large rise in their outpatient healthcare costs is due to the base effect.

If the base effect is not important, *real events* in the cantons' healthcare sectors are responsible for particular changes in average cantonal costs. Further investigations could reveal whether cost differences between cantons were accentuated or reduced in the last decade. And if, indeed, *reductions* in cantonal MHI cost differences could be observed—this is actually the case in Switzerland—it poses a question about the reasons for this trend: why did the healthcare costs in formerly "cheap" cantons grow more quickly than in formerly "expensive" cantons? Was there an undersupply in formerly "cheap" cantons that is about to be compensated? Or, was there an oversupply in the formerly "expensive" cantons that is about to be reduced? Were there actually (more) cost containment programs initiated in formerly "expensive" cantons? What types of programs were these, and did they start to have effects on the costs? Politicians and citizens expect answers to these questions from health economists and statisticians. To do so, one must rely on a sufficient base of statistical data. The following discusses the concrete health data situation in Switzerland.

2.4 Switzerland's health data situation

A large variety of health- and healthcare-related statistical data sources exist in Switzerland. A comprehensive overview of sources offering data on the national level has been made available in a publication of the Swiss Health Observatory (Roth and Schmidt 2010b). The assessment of the national healthcare information system provided by this publication parallels the model showing the factors influencing Switzerland's regional differences in healthcare costs in Figure 1. In this model, a distinction is made between the three main components of a healthcare system: the demand-side (i.e., the resident population and patients), the supply-side (healthcare production system), and the financing-side (healthcare funding system).

The Swiss Population Census (SPC) can be used to describe the *demand-side (population and patients)* component (FSO 2011h). The SPC collects various types of socioeconomic data about every inhabitant of the country. Performed every ten years, the SPC was last taken in 2010. Based on the SPC, annually actualized statistics are available about the population on the municipality level, including annual variations in areas such as births, immigrations, emigrations, and deaths (FSO 2011b). The SPC can also be linked to the Cause of Death Statistics (CDS), (FSO 2011e)[33]. By combining these two sources at the level of the individual, the Swiss National Cohort (SNC) database was created (SNSF 2011). There are cantonal cancer registries covering the populations of 22 cantons and approximately 68 percent of the total population (Bouchardy et al. 2011). The ability of these cancer registries to interpret the observed variations in prevalence across time and geographical areas is said to be limited.

Aside from these cancer registries, epidemiological data in Switzerland is rather scarce[34]. Most additional information is collected in the Swiss Health Survey (SHS) (FSO 2011f). The SHS is administered every five years; the next wave will commence in 2017. Because the information collected in this survey is self-reported, only a few, rather uncomplicated clinical syndromes can be compiled. Another problem with the SHS is its sample size: with approximately 19,000 interviewees, it actually is too small for use in calculating significant indicators for most variables within a geospatial dimension (i.e., cantons or smaller regions). A third problem is the SHS's complete exclusion of people in nursing homes or hospitals, which was corrected in 2008 and 2009 by establishing an additional survey (FSO 2011g) for this part of the population.

In addition to the SHS, two other important *panel data* sources can be mentioned: the Swiss Household Panel (SHP) (FORS 2013) and the Survey of Health, Aging and Retirement in Europe (SHARE) (IEMS 2013). The SHP is a yearly panel study (administered since 1999) that has longitudinally followed a random sample of households in Switzerland. It covers a broad range of topics in the social sciences by including questions about the health status, health-relevant behaviors and health utilization of the interviewees. The SHP is operated by

33 The Cause of Death Statistics is a comprehensive survey based on data from civil registries and death certificates issued by medical doctors. It contains the causes of death (ICD-10) by age, sex, civil status, occupation, municipality of residence and nationality.

34 There are also some reproductive statistics and newborn health data (e.g., prematurity, weight at birth, multiple births, infant mortality and prenatal mortality) collected by the FSO.

the Swiss Centre of Expertise in the Social Sciences (FORS). The other panel data source, SHARE, is a multidisciplinary and cross-national panel database of micro data on the health, socioeconomic status and social and family networks of more than 85,000 individuals from 19 European countries (including Switzerland and Israel) aged 50 or over. It is designed to be consistent with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Aging (ELSA). The responsibility for the Swiss part of the survey falls upon the Institute of Health Economics and Management (IEMS) of the University of Lausanne.

With respect to the second component of the healthcare system, the supply-side or *healthcare production system*, data collection for inpatient and outpatient service providers is differentiable in Switzerland. Since 1998, the Swiss Federal Statistical Office (FSO) has provided exhaustive data from inpatient acute care hospitals (FSO 2011c) and from inpatient nursing homes and homes for handicapped persons (FSO 2011d). Although the data on nursing homes (see Chapter 5) and homes for the handicapped are much more institution-oriented,[35] the statistics on acute hospital care (see Chapter 6) are institution-oriented *and* patient-oriented at the same time. This latter combination means that, for every inpatient hospital case, the socio-demographic information about the patient, his diagnoses, and his treatments are collected. Not available in these exhaustive statistics are the individual costs of an inpatient case. For this purpose, the FSO provides the statistics of diagnosis-related costs of hospital cases, produced with the cases of a sample of 40 voluntarily participating acute care hospitals in Switzerland (FSO 2011k).

Concerning *outpatient* providers, the information system is still much less developed. There exist institution-oriented statistics on long-term and post-acute outpatient care (Spitex) (FSO 2011l). However, there remains a complete lack of access to national data on diagnoses, treatments, and outcomes for patients in private medical practices and in outpatient hospitals. Attempts to improve this situation are underway at the Federal Statistical Office, but political, financial, and structural difficulties have thus far made these attempts ineffective.

The financing-side of the healthcare system is statistically more developed, in particular for the MHI-funded services. There are at least four data sources to be mentioned in the MHI sector, of which the individual invoices of the health service providers are always the starting

35 Since 2006, the statistics of socio-medical institutions (SOMED) also have provided some individual information available on residents and personnel in nursing homes (see Chapter 5).

point. These invoices covered by the MHI are sent to health insurance companies by the health service provider or by the patient[36]. The MHI companies aggregate the information on the invoices into groups of patients differentiated by age, gender, and residence (municipality); then, it is sent to santésuisse, the Swiss association of health insurers. There, the “Datenpool santésuisse” (DPS, see Section 4.3) (santésuisse 2011a) is produced, which organizes MHI costs by groups of patients and by canton and service provider. The DPS also details the quantities of MHI services delivered (see Chapter 4), including the numbers of consultations in medical practices and outpatient hospitals and numbers of days spent in hospitals and nursing homes.

Outpatient treatment in Switzerland is regulated by a nationwide scheme of tariffs, called TARMED. This information is collected the same way as the DPS statistics. The corresponding database is called the Tarifpool santésuisse (TPS) (santésuisse 2011b). TPS can be used in investigations of quantity structures in outpatient care covered by the MHI. The third data source in the MHI sector is very similar to the TPS and is called Datenpool Newindex (DPN) (Newindex 2011). The main difference is that independent medical practitioners (hospitals do not participate in the DPN) input their TARMED information via so-called “Trust Centers” and create their own statistical dataset. The DPN contains the invoices of all services delivered by the medical practices regardless of whether they are covered by health insurance. The fourth data source (Statistik der obligatorischen Krankenpflegeversicherung) is similar to the DPS, but aggregated information alone is transferred from the insurance companies to the Federal Office of Public Health (FOPH). The FOPH uses this information for its surveillance of the MHI companies and produces a database and statistical outputs (FOPH 2011a).

These four MHI databases allow a good overview of the cost and quantity structures in the areas of Swiss health care financed by the MHI. Their greatest disadvantage is that they are only available in aggregated form and do not contain information about diagnoses, treatments, or outcomes. Moreover, the services covered by the MHI include only 35 percent of all healthcare costs in Switzerland (see Table 2). For healthcare services funded by the other

[36] If the patient does not transfer the invoice to the insurer (e.g., because of a high deductible), the information is lost from the statistics.

sources—viz., out-of-pocket expenditures, state subsidies, and private health insurers—no convincing cantonal or regional statistics are available.

In summary, the Swiss health data situation can be described as “average.” The strengths of the statistical information system lie in the data that cover inpatient healthcare provision—acute care hospitals in particular and nursing homes to a somewhat smaller degree. Regarding healthcare funding, there is rather detailed (albeit aggregated) cost and service structure information accessible for the health sector funded by MHI; only the insurance companies compile individual MHI data at present. On the demand side of the healthcare system, the best data sources are the Swiss Population Census, the Cause of Death Statistics, the Swiss National Cohort, the Swiss Household Panel, the Survey of Health, Aging and Retirement in Europe, and the Swiss Health Survey. Limited sample sizes and limited regional validity is always an issue in the three surveys last-mentioned.

The most important weaknesses of the information system last in the sector of outpatient healthcare provision. The lack of individual-level and diagnosis-related information on the financing side of health care provided by MHI must be stressed. Missing as well are useful regional data for all other payers, such as private households, the state, and private health insurance. Finally, epidemiological data on the demand side is excellent for the measurement of mortality (FSO 2011e), but insufficient for morbidity (Bouchardy et al. 2011; FSO 2011f, 2011g). In an aging society with growing prevalence of chronic disease, this lack of morbidity statistics will become especially significant in the near future.

3 Findings from an international empirical literature review

3.1 Methodology

The presentation of the empirical literature about regional cost differences in Chapter 3 is mostly based on a comprehensive literature review published in 2008 (Camenzind 2008). The following research questions were adressed in this literature review.

- Are there recognized theoretical and empirical models for the explanation of differences in regional healthcare cost and regional health service utilization?
- Are there possibilities for integrating concrete—national or regional—health system elements into such models?
- Are there proven effects on regional cost and utilization differences? Are there changes in such effects over time?
- Is there an optimal level of functional aggregation of healthcare costs?
- Do the same effects cause differences in levels and differences in trends of healthcare costs?
- How does the current state of statistical data in Switzerland compare to those of other Western countries?
- Is there an optimal geographical level of analysis? What are the interrelations of the spatial dimension with data and methods?
- What are the methodological approaches for empirical models applied to Switzerland?

Based on these research questions, search indices were defined[37] to detect the relevant publications in the following electronic libraries: Econlit, the Cochrane Database of Systematic Reviews, Medline, HSTAT, RePEc, and the Internet (Google Scholar). The concrete work of the literature review was completed in the spring and summer of 2007.

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37 See Camenzind, P. A. 2008. “Erklärungsansätze regionaler Kostenunterschiede im Gesundheitswesen.” *Arbeitsdokument 30.* Obsan. Neuchâtel: Swiss Health Observatory. S. 24 f: cantonal, cross-national, cross-provincial, cross-state, disparities, expenditures-on-health-(care), federalism, federal-state, (multi-level)-governance, (national)-government-expenditures-and-health, health-care, health-care-expenditure(s), (analysis-of)-health-care-markets, health-care-services, health-care-utilization, health-costs, health-economics, health-expenditures, health-government-policy, health-income-growth, health-inequalities-decomposition, health-insurance, health-policy, inequality, panel-data, provincial, (cross)-regional, state-and-local-government-(health), regional-policy, state-and-local, Switzerland, Swiss.

This methodology pulled several hundred articles that were subsequently reduced to approximately 300 papers by reading the abstracts. The 300 selected papers were classified into three groups of approximately 100 papers each with respect to their potential to answer the research questions. The 100 studies with the greatest estimated potential were studied in full text and documented in a scheme representing the research questions (Camenzind 2008). Since the beginning of this formal research in 2007, the scientific literature has been continuously observed, and repeated Internet searches were executed.

3.2 Theoretical findings

The results of the myriad trials to create theories or theoretical models to describe precisely how healthcare costs come into existence are not really satisfying. A comprehensive review from 1965 to 1998 by Gerdtham and Jönsson (2000) reveals this theoretical basis problem; this is even more convincingly revealed in the work of Martin et al. (2011) for the period from 1998 to 2007. Both sets of authors agree that healthcare systems are too complex[38] to develop complete or satisfactory theoretical models.

A recent article in the 2012 edition of the Handbook of Health Economics (Skinner 2012) is more optimistic and offers an additional promising step: it discusses the causes and consequences of regional variations in health care systematically on the basis of the *theoretical economic model*. Mathematical formulations regarding the demand and supply sides of the healthcare system are given[39], and a typology of three categories of healthcare services is presented[40].

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[38] See Chapter 1 of the document.

[39] For a complete derivation of the model, see Chandra, A. and J. Skinner. 2012. “Technology Growth and Expenditure Growth in Health Care.” *Journal of Economic Literature* 50(3): 645–80.)

[40] The first of the 3 categories consists of highly effective treatments, such as antibiotics for infections and beta blockers for heart attack patients. The second category exhibits considerable heterogeneity in benefits across different types of patients. An example here is back surgery, which may be very effective for one diagnosis (e.g., spinal stenosis) but for which much less may be known about its value for other patients (e.g., those without any organic cause for the back pain). The third category consists of treatments that are little or poorly supported by the evidence. Arthroscopy of the knee is one such example cited in the aricle by Skinner (2012).

The *demand-side* formulation of the model is a simplified two-period model of consumption and leisure in which perceived quality of life is influenced (solely, as there are no "health stocks") by medical spending. The utility of the individual is maximized subject to a budget constraint. The author derives a function of individual demand for an extra quality-adjusted year of survival, which can vary across regions for the following reasons: income, risk aversion, and time preferences of the individuals.

For the *supply side* of the model, it is assumed that healthcare providers maximize the value of their patients' health subject to their own financial considerations (i.e., income), resource capacity, ethical judgments, and patient demand (expressed in the demand-side function described above). The combination of constraints (viz., income, resource capacity, and ethics) is summarized by a "shadow price"[41]. Using this formulation, the model is able to describe regional variations in costs and utilization of healthcare services through two distinct classes of such variations across regions.

First, if all healthcare providers are subject to the *same production function*, regional variations in the utilization of healthcare services occur because of *variations in the shadow price* (i.e., in the combination of the different constraints). This outcome can be caused by variations in marginal financial incentives arising from differences in reimbursement rates and prices for services across regions and varying sensitivities of providers to such financial incentives. It can also be caused by variations in capacity (e.g., regional density of providers) or ethical constraints, by patient price or access (e.g., insurance coverage and distance to providers), and by malpractice risks. Second, the production function is allowed to differ across regions and providers; this occurs because of regional differences in the health status of the population or higher productivity, better skills, different approaches to treatments, or systematically different organizational structures of the providers.

The model (Chandra and Skinner 2012; Skinner 2012) seems to offer a good starting point for a more systematic analysis of geographic variations in healthcare costs and utilization. However, as with all other studies of international or intra-national healthcare cost and utilization differences, the simplified model of Skinner (2012) still faces the difficulty that only a limited set of features of the healthcare system and its influencing factors can be

[41] For example, if financial incentives for the physician to do more are offset by ethical standards to do no harm to the patient, the shadow price is zero.

modeled. Nevertheless, if the model can be further developed, it might help researchers to be less obliged to rely on their intuitions and their professional and personal experiences (Gerdtham and Jönsson 2000).

3.3 Empirical findings

In international comparisons[42], a nation's aggregate income seems to be the most important factor in explaining variations in healthcare expenditures (Gerdtham and Jönsson 2000). Not definitively answered is whether the estimated income elasticity is smaller or larger than unity. Thus, it is still an open question—albeit of more academic than concrete political interest—whether health care shares some of the features of a luxury good.

Moreover, in many of these international studies, aging populations, technical progress and territorial centralization have been found to be the main drivers of healthcare expenditures. Those findings notwithstanding, the empirical evidence for some of these factors is still "not too solid" (Martin Martin et al. 2011). The same can also be said for variables such as higher densities of general practitioners (GPs) and specialists in private practice or the existence of more beds per capita in acute care hospitals.

Researchers have found some evidence for the cost-containing effects of organizational reforms of healthcare systems. One such element is the regulation of access and the organization of the "patient walks" through the healthcare system by GPs, also called gatekeeping[43] or case management[44]. Other elements refer to the financing of health care by diagnoses' specific global budgets or flat rates (capitation[45]). The discussion about the general funding of the healthcare system is still controversial. To present, Buchanan's (1965) or Leu's

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[42] These results are mostly obtained by cross-sectional regression methods or by combined cross section-time series (i.e., panel econometric) approaches.

[43] Gatekeeping is understood here as the specific coordination of healthcare provision by a specially qualified medical doctor (usually, a GP). In the cases of illness or accident (not in emergencies), this GP ("gatekeeper") is always the first point of contact for the patient in the healthcare system, and the gatekeeper guides the patient along the medical supply chain.

[44] Case management stresses the coordination function and guidance of the patient in the healthcare system. Compared to gatekeeping, the case manager is normally not the first point of contact and not a medical doctor (it is often a collaborator supplied, in the case of Switzerland, by an insurance company or an HMO).

[45] See footnote 5.

(1986) hypothesis of a higher share of public funding leading automatically to greater health consumption has neither been confirmed nor rejected.

On the demand side of healthcare system, higher educational levels of populations seem to have cost-cutting effects. In Switzerland, this is at least true in the area of mandatory health insurance (MHI) and for inpatient healthcare services (Bisig and Gutzwiler 2004; Schellhorn 2002), whereas for private healthcare spending and for outpatient healthcare services, it may be the reverse. Additionally, good integration into the labor market seems to have the same effects on positive health outcomes as higher educational levels (Fasel, Baer, and Frick 2010).

The results found in studies of intra-national healthcare cost differences in Canada, Spain, France, and the US—and sporadically, too, in the UK, Italy, Denmark, and Germany—were very similar to those found in international comparisons[46]. Cost-driving effects on health care were found to be related to, in particular, higher income levels, a greater share of elderly people and women, greater unemployment, lower educational levels, more persons with poor health status, higher densities of physicians in private practice, more hospital beds per capita, better health insurance coverage, higher subsidies of the central state authority to the member states and—often most important—the general medical-technical progress.

The advantage of intra-national studies is that they have to fight less with the problem of large differences in the organization and funding of the healthcare system compared to international studies. However, intra-national studies often suffer from few observation points that come from a limited number of member states (e.g., provinces, cantons, Bundesländer), and the problem of missing data on detailed regional levels is omnipresent.

The problems mentioned for international and intra-national studies are also relevant for analyses of cantonal differences in levels of and trends in healthcare costs in Switzerland. Additionally, the broad heterogeneity in area size and population of the Swiss cantons (see Section 1.3) and the almost complete lack of data (see Section 2.4) on smaller regional levels, such as districts or municipalities, limits the validity of such empirical investigations. Under these restrictions, the intra-national (i.e., cantonal) empirical literature (Crivelli et al. 2008; Crivelli, Filippini, and Mosca 2003a; Haari et al. 2002; Reich et al. 2011; Rüefli and Vatter 2001; Schleiniger, Slembeck, and Blöchlinger 2007; Stadelmann 2011; Wildi, Unternährer, and

[46] Additionally, these intra-national studies are mostly based on cross-sectional regression or panel econometric methods.

Locher 2005) for Switzerland finds cost driving effects from aging populations and larger shares of women, urban populations structures, lower education levels, higher unemployment rates, a Latin language and culture “effect” (i.e., French-, Italian-, and Rhaeto-Romanic-speaking parts of the country), higher density of physicians in private practice, more pharmacies per capita and medical-technical progress in general.

In contrast to findings from international comparisons, no agreement has been reached regarding the effect of average cantonal income per capita and per capita healthcare expenditures. Studies suggesting positive or negative associations both exist. Other factors influencing Swiss healthcare costs in an empirically significant way also exist, although they are found less regularly. Such factors include cantonal mortality rates, the growth of the nominal wages, the density of acute care hospital beds, the share of specialized hospitals among all acute care hospitals, the quantity of drugs sold in physicians’ practices, the prices of healthcare commodities, the share of socially destitute persons, and the share of foreigners in the resident cantonal populations (Camenzind 2008; Crivelli et al. 2008; Crivelli, Filippini, and Mosca 2003; Haari et al. 2002; Reich et al. 2011; Rüefli and Vatter 2001; Schleiniger, Slembeck, and Blöchlinger 2007; Stadelmann 2011; Wildi, Unternährer, and Locher 2005).

To summarize, the international and national health economic literature still faces some difficulties providing consistent answers to important research questions (see Section 3.1) in the field of regional healthcare cost differences. The origins of these serious weaknesses definitely stems from the lack of broadly recognized empirical explanatory models available to the field. This situation, also described as the “*quest without a compass*” for explanatory factors (Culyer 1988), has continued to the present, but promising advances are underway (Chandra and Skinner 2012; Skinner 2012). With regard to the second serious weakness, the lack of available data, the field has progressed over the last 20 years: the development of health statistics information systems is underway, both internationally and in Switzerland.

3.4 Methodological findings

The methodological questions in the literature review pertained to the different meanings of levels and trends of healthcare costs and utilization, the best statistical-technical approaches to be applied to the analysis of the Swiss healthcare system, the optimal statistical and geographical aggregation levels for such an analysis, and the current state of statistical data in Switzerland (see Section 2.4). As was the case in Sections 3.2 and 3.3, only a short summary of the methodological findings is given here. For more detailed information, please refer to the complete work (Camenzind 2008).

The review of the empirical health economic literature revealed that, in older studies from 1960 until 1990, researchers mainly tried to explain different national *levels* (and not trends) of healthcare costs (and utilization). The methods they principally used for that purpose were descriptive statistics, bivariate correlation analyses, or cross-sectional regressions. Since then, the foci of international scientific papers has increasingly turned to trends in healthcare costs and utilization, without losing the former interest in explaining differences in national levels. Such a turn towards the *simultaneous investigation of trends and levels* of healthcare costs (and utilization) seems to be attributable to at least three sources.

First, during the 1990s, politicians in many Western countries became aware of the growing trends in healthcare expenditures in the preceding decades. These politicians started to clamor about whether and how these trends could continue into the future and what political measures could stop or slow down these trends. Second, most Western countries developed their statistical information systems, and broader and more detailed statistical data became available. Moreover, continuous data collection resulted in more detailed time series of data being ready for researchers' use. Technological progress made storage and access to such databases easier and less expensive. Third, instruments designed to *simultaneously* analyze differences in the levels of and trends in the indicators became available. These instruments were continuously integrated into newly developed software packages. With such advances, it was no wonder that *panel econometric approaches* became the standard method to be applied when explaining differences (simultaneously in level and trends) in national or regional healthcare costs and health services utilization.

Two approaches using panel econometric models are most often applied to the studies of interest. These include models with unobservable *fixed* linear effects (FE-models) and models with unobservable *random* linear effects (RE-models). One main difference between the two families of models is how they treat the cross-sectional effects of the observations—in our case, the specific influences of the different countries, cantons, or regions. RE-models make the assumption (to produce unbiased estimators) that the random effects have to be uncorrelated with the independent variables. Adherence to this assumption—together with the research question and the availability and characteristics of statistical data—determines the choice of the model. Various statistical tests[47] support this choice from a mathematical perspective.

Quite solid answers to two of the initial research questions (see Section 3.1) can be given with these findings of the literature review. It is, indeed, an advantage to take into account varying levels of and varying trends in healthcare costs, because different sets of cost drivers can influence these two dimensions. Panel econometric approaches, with their capacity to combine cross-sectional and time-series analyses, are the ideal statistical-technical approach for tackling this type of research question. An example of a panel-econometric application for the Swiss healthcare system is presented in the first article of Part II (see Section 4).

The other initial research questions pertained to the optimal statistical and geographical aggregation levels applicable to the analysis and the existence of realizable models considering the data situation in Switzerland. From a theoretical point of view, the statistical and geographical levels of data that offer the most possibilities are individual and geo-coded data (i.e., the individual patients or the individual healthcare providers). With every aggregation step during the analysis, some of the variation between the individual observations is eliminated. Moreover, separate analyses of three main components of healthcare costs—the quantities used, the prices paid, and the medical practice applied (OECD 2011b)—should be favored.

It would have been desirable to work on a regional level well under the cantonal territories. Unfortunately, the Swiss health data do not permit working with more homogenous geographical units such as political districts or even municipalities. As consequence, the three empirical investigations in Part II do not fall under the cantonal level; however, further research efforts should aim to facilitate movement in the direction of smaller and more homogenous geographical units.

[47] A standard test used to choose between FE- and RE-models is the Hausman test (see Chapter 4, Part II).

Appendix, Part I

Table 3: Healthcare costs as a share of GDP and life expectancy at birth in selected OECD-member countries, 2009, in percentages

2009	Health care costs as share of GDP in %	Life expectancy at birth in years
Austria	10.4	80.4
Belgium	10.1	80.0
Canada	10.3	80.7
Denmark	10.3	79.0
Finland	8.4	80.0
France	11.1	81.0
Germany	10.7	80.3
Italy	9.0	81.8
Netherlands	9.9	80.6
Norway	8.6	81.0
Spain	9.0	81.8
Sweden	9.2	81.4
Switzerland	10.7	82.3
United Kingdom	8.8	80.4
United States	16.4	78.2

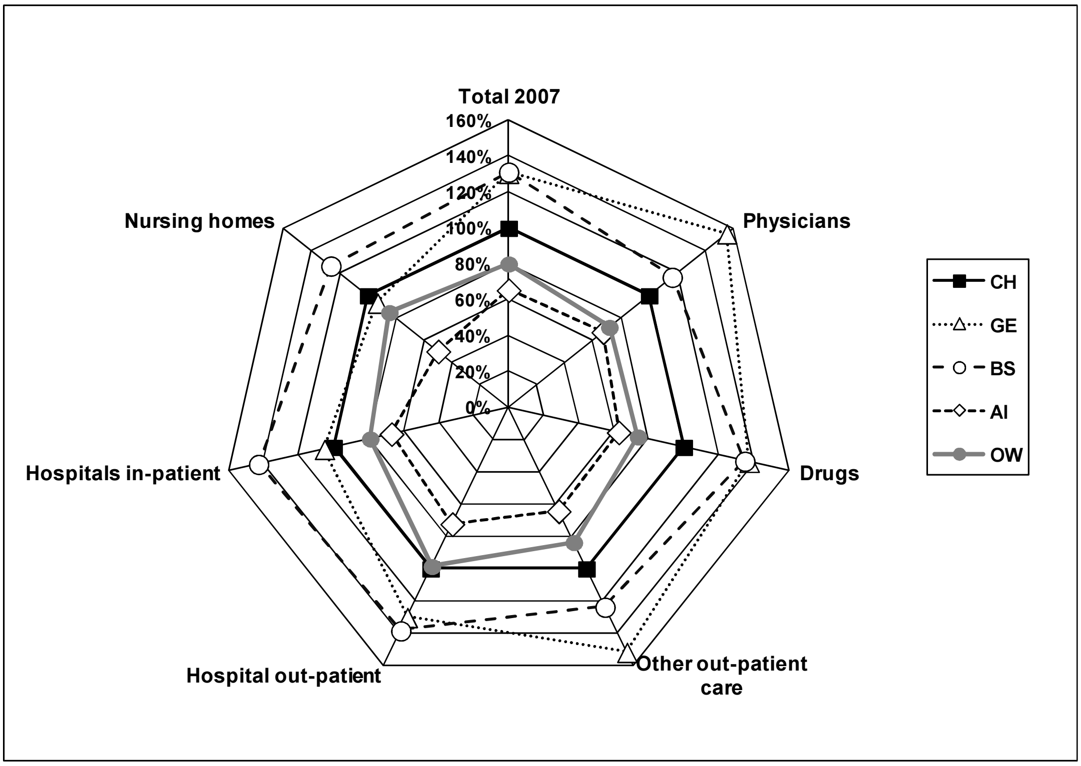
Source: OECD Health Data Base; as of 08/24/2011 (OECD 2013).

Table 4: MHI costs, state subsidies, and out-of-pocket expenditures per capita, by canton, 2007, in CHF

Cantons	Mandatory health insurance costs 2007 (1)	State subsidies 2007 (2)	Out-of-Pocket 2006 (3)	Total costs (1) + (2) + (3)	Resources index 2011 (4)
AI	1,871	496	848	3,215	80.5
OW	2,291	803	497	3,591	74.0
GL	2,400	780	790	3,969	65.4
UR	2,368	774	883	4,025	57.2
NW	2,214	823	1,036	4,073	124.5
TG	2,447	491	1,301	4,238	73.1
AG	2,571	566	1,180	4,316	84.5
JU	2,853	967	513	4,333	62.3
AR	2,222	1,017	1,123	4,362	74.1
LU	2,378	716	1,343	4,436	74.1
SZ	2,414	697	1,417	4,528	140.1
SG	2,365	807	1,393	4,564	73.6
VS	2,595	1,079	1,130	4,805	64.3
FR	2,691	1,068	1,083	4,842	68.1
GR	2,510	1,054	1,340	4,904	76.9
SH	2,718	1,186	1,001	4,906	95.9
SO	2,795	965	1,192	4,952	76.5
ZH	2,811	912	1,319	5,042	127.8
BL	2,978	899	1,234	5,111	98.2
CH	2,860	1,085	1,235	5,180	100.0
ZG	2,394	1,270	1,585	5,249	246.1
NE	2,981	1,334	1,138	5,453	94.1
TI	3,366	1,185	1,067	5,618	95.4
BE	3,087	1,351	1,205	5,643	74.9
VD	3,239	1,270	1,134	5,643	120.1
BS	3,755	1,986	1,162	6,903	144.7
GE	3,737	2,174	1,542	7,454	146.9

Sources: (1): Datenpool santesuisse (santésuisse 2011a); (2): State subsidies (EFV 2011a); (3): Out-of-pocket expenditures (Stadelmann 2011); (4): Resources index (EFV 2011b); calculations by the author.

Figure 10: Index of MHI costs per capita by domains of service providers for selected cantons, 2007, in percentages (CH = 100 percent)



Source: Datenpool santesuisse, calculations by the author (see Table 5).

Comment: In Figure 10, the indices for the total costs and the six provider domains are calculated so that the average value for Switzerland (CH) is always set at 100 percent. The results of only four cantons are demonstrated and discussed in the following paragraphs: the two most expensive cantons, BS and GE; the least expensive canton, Appenzell Innerrhoden (AI); and the fourth-least expensive canton, Obwalden (OW, see the Excursus in Part III of the thesis).

For BS and GE, the average total MHI costs are at an index of 131 percent, meaning total MHI costs for these two cantons are 31 percent higher than for the country on average. The cantons AI and OW have indices here of 65 percent and 80 percent, respectively, meaning that the expenses for services covered by the MHI are 35 percent less in AI and 20 percent less in OW than the national level.

Concerning the individual domains of service provider costs, some differences in the composition of the MHI costs of the two cantons BS and GE can be discussed. In particular, the high total average MHI costs in canton BS are caused by high costs for outpatient hospital care (138 percent), for drugs (135 percent), for inpatient hospital care (143 percent), and for nursing homes (127 percent). In canton GE, high costs for outpatient hospital care (130 percent) and for drugs (137 percent) principally contribute to high MHI costs. However, unlike in BS, the other two important "cost-drivers" in GE are the physicians (private practitioners; 155 percent) and other outpatient care (e.g., Spitex, physiotherapy; 152 percent).

For the least expensive canton, AI, not only the total average MHI costs per capita of inhabitants but also the average MHI costs for all six selected domains of service providers are well below the Swiss average. These average costs amount to only 50 percent for nursing homes, as the lowest comparison group, to 72 percent for outpatient hospital care as the highest comparison group. For OW, the index for hospital outpatient costs (98 percent) is almost equal to the country's average; the other five service domains cost between 28 percent (physicians) and 15 percent (nursing homes) less than the Swiss average.

Table 5: Index of MHI costs per capita by domains of service providers, by canton, 2007, in percentages

Cantons	Total index 2007 (CH = 100)	Index physicians	Index drugs	Index other out-patient care	Index hospital out-patient	Index hospitals in-patient	Index nursing homes
AI	65%	67%	63%	64%	72%	67%	50%
NW	77%	73%	73%	91%	86%	76%	73%
AR	78%	76%	70%	69%	87%	80%	92%
OW	80%	72%	74%	84%	98%	79%	85%
SG	83%	86%	81%	79%	80%	83%	85%
UR	83%	76%	76%	72%	91%	87%	104%
LU	83%	78%	78%	80%	88%	83%	107%
ZG	84%	90%	74%	83%	79%	87%	92%
GL	84%	81%	82%	89%	89%	77%	105%
SZ	84%	92%	80%	82%	79%	81%	95%
TG	86%	78%	72%	83%	93%	101%	85%
GR	88%	79%	89%	94%	87%	90%	95%
AG	90%	86%	96%	81%	92%	98%	67%
VS	91%	87%	103%	87%	87%	91%	80%
FR	94%	95%	98%	87%	86%	94%	105%
SH	95%	90%	104%	91%	96%	91%	104%
SO	98%	95%	99%	100%	100%	106%	70%
ZH	98%	116%	94%	94%	89%	89%	109%
JU	100%	77%	112%	99%	110%	101%	115%
CH	100%	100%	100%	100%	100%	100%	100%
BL	104%	115%	101%	107%	107%	108%	62%
NE	104%	87%	121%	121%	85%	95%	155%
BE	108%	92%	98%	103%	104%	129%	128%
VD	113%	110%	121%	124%	146%	92%	95%
TI	118%	106%	124%	125%	101%	129%	125%
GE	131%	155%	137%	152%	130%	105%	93%
BS	131%	116%	135%	124%	138%	143%	127%

Source: Datenpool santesuisse (santésuisse 2011a), calculations by the author.

Table 6: MHI costs per capita by domains of service providers, by canton, 2007, in CHF

Cantons	Physicians in private practice (18%)	Drugs: physicians & pharmacies (23%)	Other out-patient care (10%)	Hospital out-patient (16%)	Hospitals in-patient (24%)	Nursing homes (9%)	Total (100%)
AI	441	366	186	305	461	111	1,871
NW	476	425	264	365	524	161	2,214
AR	495	407	198	367	550	204	2,222
OW	470	430	242	416	545	189	2,291
SG	564	473	229	337	572	189	2,365
UR	499	444	209	385	600	232	2,368
LU	511	455	232	371	572	237	2,378
ZG	590	429	241	335	597	203	2,394
GL	531	475	256	375	530	232	2,400
SZ	605	465	238	335	561	211	2,414
TG	512	421	239	391	694	188	2,447
GR	520	516	271	368	624	212	2,510
AG	564	558	236	389	677	148	2,571
VS	570	601	253	366	627	178	2,595
FR	623	570	252	364	650	233	2,691
SH	587	603	264	405	627	232	2,718
SO	620	577	289	424	730	154	2,795
ZH	759	549	272	375	615	241	2,811
JU	502	650	285	467	695	254	2,853
CH	655	582	289	423	689	222	2,860
BL	751	588	308	452	742	137	2,978
NE	568	705	350	361	653	344	2,981
BE	603	572	297	438	892	284	3,087
VD	718	704	359	615	632	210	3,239
TI	692	721	361	427	888	277	3,366
GE	1,018	799	439	550	724	207	3,737
BS	763	785	358	585	984	281	3,755

Source: Datenpool santesuisse (santésuisse 2011a), calculations by the author.

Table 7: Average annual changes in MHI costs per capita by domains of service providers, by canton, 2000–2007, in percentages

Cantons	Total of MHI health care costs	Total of MHI out-patient care costs	Total of MHI in-patient care costs	Costs of physicians in private practice	Costs for drugs by physicians & pharma-cies	Costs for other out-patient care	Costs for hospital out-patient	Costs for hospitals in-patient	Costs for nursing homes
NE	2.0%	2.7%	0.7%	2.9%	3.2%	4.0%	0.7%	-0.5%	3.5%
VD	2.8%	3.5%	0.8%	2.9%	3.5%	3.2%	4.5%	0.7%	1.3%
GE	2.8%	3.0%	2.0%	2.1%	3.6%	2.9%	4.2%	3.0%	-1.0%
JU	2.8%	3.2%	2.0%	2.8%	3.4%	2.1%	4.3%	0.7%	6.1%
BS	3.4%	4.2%	2.2%	1.6%	5.8%	1.2%	8.4%	1.0%	7.5%
SH	3.5%	4.1%	2.3%	2.6%	4.2%	4.1%	6.2%	2.0%	3.3%
TI	3.5%	3.1%	4.4%	1.6%	3.0%	3.3%	5.9%	4.1%	5.4%
GL	3.6%	3.4%	4.0%	1.6%	2.1%	7.1%	6.0%	2.6%	7.7%
TG	3.7%	3.7%	3.6%	2.7%	3.1%	4.0%	5.9%	4.0%	2.4%
ZH	3.8%	3.8%	3.8%	2.3%	4.3%	4.2%	6.0%	4.1%	2.8%
AI	3.8%	4.7%	2.1%	2.9%	4.9%	5.5%	6.7%	1.3%	6.0%
CH	4.0%	3.9%	4.3%	2.8%	3.6%	3.9%	6.3%	4.4%	3.9%
AR	4.1%	4.0%	4.4%	2.7%	3.4%	4.9%	6.0%	3.6%	6.6%
FR	4.2%	4.0%	4.5%	3.6%	2.6%	3.8%	7.8%	4.3%	5.0%
BL	4.2%	4.4%	3.9%	2.5%	4.2%	4.4%	8.5%	3.4%	6.6%
VS	4.3%	4.3%	4.2%	3.9%	3.4%	3.4%	7.7%	3.1%	9.1%
GR	4.6%	4.9%	3.9%	2.3%	3.8%	4.3%	13.1%	2.5%	8.8%
AG	4.6%	4.5%	4.9%	3.2%	3.9%	5.1%	7.0%	5.6%	2.1%
SG	4.7%	4.7%	4.6%	3.5%	3.7%	4.7%	9.1%	4.2%	6.0%
NW	4.7%	4.6%	5.2%	3.1%	4.8%	5.2%	5.9%	5.0%	5.8%
OW	4.8%	4.4%	5.8%	2.3%	5.1%	3.3%	7.1%	5.6%	6.2%
UR	5.0%	4.0%	7.1%	2.8%	2.8%	5.3%	6.5%	5.4%	13.1%
SZ	5.1%	4.7%	6.0%	3.8%	4.0%	4.1%	8.8%	5.1%	8.7%
LU	5.2%	5.1%	5.3%	4.6%	4.0%	4.3%	8.3%	4.7%	7.0%
BE	5.2%	3.7%	8.1%	3.0%	2.5%	4.3%	6.4%	10.0%	3.5%
SO	5.3%	4.8%	6.4%	3.3%	4.3%	5.7%	7.7%	7.2%	3.1%
ZG	5.3%	4.2%	7.9%	4.0%	4.1%	3.6%	5.2%	7.2%	10.3%

Source: Datenpool santesuisse (santésuisse 2011a), calculations by the author.

Part II: Empirical Essays

4 Explaining regional variations in healthcare utilization across the Swiss cantons using panel econometric models[48]

5 Cost differences in Swiss nursing homes: a multilevel analysis

6 Demography and future requirements of inpatient acute care in Swiss hospitals

[48] A former version of the article has been published in BioMedCentral Health Services Research Journal: 13 March 2012: see: http://www.biomedcentral.com/1472-6963/12/62/abstract.

4 Explaining regional variations in healthcare utilization across the Swiss cantons using panel econometric models

Abstract

There exist large cantonal variations in volumes of healthcare services in Switzerland. In this article, the important factors interrelated with these regional differences are examined. Using a selected set of these factors, individual panel econometric models are calculated to explain variations in utilization for each of the six largest healthcare service domains: general practitioners, specialist doctors, inpatient hospitals, outpatient hospitals, medications, and nursing homes participating in the Swiss mandatory health insurance (MHI) program. The main data source is "Datenpool santésuisse," a database of Swiss health insurers. For all six healthcare service domains, significant factors influencing utilization frequencies over time and across cantons are found. A greater supply of service providers tends to strongly correlate with per capita consumption of MHI services. On the demand side, older populations and higher population densities afford the clearest positive associations.

4.1 Background

Switzerland is a small Western European country with a population of 7.8 million persons (as of 2009) who live on a total area of 41,000 km^2. The country consists of 26 cantons, which greatly differ in terms of area, numbers of inhabitants, population density, socioeconomic situation, and language (see Figure 2).

Table 8: Swiss "market" for mandatory health insurance (MHI), 2007

Main actors / components	Number of actors	Number of beds	Ownership	MHI costs (billions of CHF)	General remarks
MHI companies	87	–	private	–	MHI companies authorized by the Confederation and obligated to contract with service providers ("contract
General practitioners in private practices (GP)	5,915	–	private	2.0 (10.6 %)	Calculated full-time employees for general practitioners, pediatricians and gynecologists in private practices (MHI
Specialist doctors in private practices	3,244	–	private	1.9 (10.2 %)	Calculated full-time employees for specialized physicians in private practices (MHI services)
Inpatient hospitals	321	41,910	public & private	4.8 (26.3 %)	General hospitals and specialized clinics for psychiatry and rehabilitation (MHI services)
Outpatient hospitals	> 130	–	public & private	2.8 (14.9 %)	General hospitals (130) normally supply outpatient care; but this is not known for all specialized clinics (181)
Drugs	1,700 / ~ 4,000	–	private	3.6 (19.5 %)	Number of pharmacies: 1,700; number of self-dispensing physicians: ~ 4,000 (MHI services)
Long-term care nursing homes	1,509	87,960	public & private	1.6 (8.7 %)	Nursing homes (excluding homes for the disabled, for addicts and persons with psychosocial problems, MHI services)
Total of MHI services delivered	–	–	–	18.5 (100 %)	Other providers account for the rest of CHF 1.8 billion (9.8 percent); MHI premium subsidies are not included here

Sources: (FOPH 2011a; FSO 2011c, 2011d; Roth 2010a), calculations by the author.

The responsibility of government is divided into three state levels: the central government (i.e., "Confederation"), the 26 cantons, and approximately 2,600 municipalities. The three levels also characterize the Swiss healthcare system, which is normally described as a system of "regulated competition" (Enthoven 1988). Briefly said, "regulated competition" implies competition between healthcare market players wherever competition seems to generate better outcomes than regulation by state authorities. Some important characteristics of healthcare market players are described in Table 8. In particular, outpatient health service providers in

Switzerland operate mainly on a private basis, while private- and public-owned institutions are responsible for the provision of inpatient services.

Although regulatory responsibilities and public funding of Swiss health care are shared by three state levels[49], the 26 *cantons* are mostly responsible for the implementation of health policy. This responsibility includes the mission to guarantee the sufficient supply of inpatient and outpatient services for their populations and to contribute the largest part of the payments provided by the state. Moreover, a moratorium (i.e., a "necessity clause") was introduced in 2002. This moratorium, giving cantons the power to regulate the establishment of new outpatient service providers, was in place for GPs through 2009 and for specialist physicians and pharmacists until 2011. Reintroducing the necessity clause for specialists and pharmacists (but not for GPs) occured in July 2013.

The *Confederation*, however, has more legislative functions in the area of MHI and supervisory functions for the MHI insurance market. It is responsible for the nationwide healthcare legislation—specifically, the definition of the national MHI benefit basket. Other federal responsibilities include the setting of standards of education and training of healthcare personnel, health protection for the population, surveillance and management of communicable diseases, and health sciences and research.

Finally, the *municipalities* see their most important role as performing the tasks handed over to them by the cantons. In most cases, these tasks involve the operation and funding of providers, either in outpatient or long-term inpatient care settings (i.e., formal care at home and in nursing homes) (Weaver et al. 2009b).

The two important characteristics of the Swiss healthcare system mentioned above—regulated competition and a federalist structure—are intensively discussed in Swiss health politics. In spite of the clear advantages the system offers, such as efficiency gains and proximity to the local populations and their requirements (Haari et al. 2002), there are also major obstacles to overcome in the system. Therefore, the system has an enormous complexity, and good governance in Swiss health care seems difficult (OECD/WHO 2011).

[49] Direct subsidies of the Confederation to healthcare providers are negligible. With regard to the overall funding of health care of CHF 61 billion in 2010 (including the Confederations' and cantons' premium subsidy payments), the shares of the 3 state levels were as follows: Confederation, 5.9 percent; cantons, 21.6 percent; and municipalities, 4.2 percent, see FSO. 2012f. "Nettofinanzbedarf der Kantone und der Gemeinden im Gesundheitswesen." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).

Certain amounts of incoherence, redundant processes, and obstructions in healthcare regulation beyond the national or cantonal level have to be accepted.

Empirically, it has never consistently been demonstrated whether, all in all, such a system leads to higher—or lower—healthcare costs than in other, comparable countries (Martin Martin et al. 2011). However, the system of regulated competition and strong federalism forms the basis for the existence of large variations in healthcare utilization and costs across geographical areas (for Switzerland, see Figure 2, and Appendix, Table 12).

Important work to identify reasons for growing and varying healthcare expenditures―and utilization―in Western countries began approximately 50 years ago (Buchanan 1966). In this research, tax-financed healthcare systems provide "free" healthcare services to users; therefore, greater shares of public financing lead to higher spending on health in such societies. In the "model of unbalanced growth" (Baumol 1967), the nominal wages in the healthcare sector must be increased, even without progress in productivity, which causes more spending on health care as the economy grows. In later studies (Leu 1986; Newhouse 1977), combinations of higher national income and greater shares of public financing were suspected to have driving effects on both the demand and the supply of health care.

Many more models with the potential to determine which factors influence healthcare costs and utilization have been developed and tested (Clemente et al. 2004; Gerdtham et al. 1998). As mentioned earlier by internationally recognized researchers (Culyer 1988; Gerdtham and Jönsson 2000; Gerdtham et al. 1998), it is very difficult to establish a widely accepted theoretical base upon which to consistently explain international or regional differences in levels and growth of healthcare expenditures (Martin Martin et al. 2011). This circumstance is due to the great complexity and heterogeneity of the organization and the financing of healthcare systems, the multiplicity of actors involved, the specific nature of "health" as an economic good (Hurley 2000), and, partly, the lack of available data. A new model, recently presented in international journals (Chandra and Skinner 2012; Skinner 2012), seems to offer a good starting point for a more systematic analysis of geographic variations in healthcare costs and utilization.

The available literature of interest continues to focus on finding factors to explain international or intra-national differences in levels and growth of healthcare costs and related components. One actual literature review about the subject (Martin Martin et al. 2011) finds rising incomes, aging populations, technological progress, and territorial decentralization as the main healthcare cost drivers in Western economies.

A Swiss study on the subject explains the regional differences in levels and growth rates of healthcare costs across the country by applying separate cross-sectional regressions for both dimensions: levels and growth rates (Rüefli and Vatter 2001). This study identified significant correlations between higher healthcare costs and greater social disintegration, higher unemployment, higher concentration of physicians, more specialized clinics, and a Latin-speaking (i.e., French- and Italian-speaking; see Figure 2) population. Later studies using panel econometric approaches (Crivelli et al. 2003; Crivelli, Filippini, and Mosca 2006; Wildi et al. 2005) found significant influences from higher income levels, older populations, higher mortality rates, denser populations, and a time trend.

"New" significant factors found in another Swiss study using cross-sectional regressions (Schleiniger et al. 2007) were higher numbers of women in the population and more pharmacies per capita. In a more recent study (Crivelli et al. 2008) applying exactly the same methods but with more recent data (Crivelli et al. 2006), a greater number of small children in the population and higher prices for MHI services were identified as significant explanatory factors for cantonal cost differences. Additionally, using econometric panel models, the most recent Swiss study to be identified (Reich et al. 2011) suggested the significant cost driving effects of a higher number of drug-dispensing physicians and more foreigners in the population, whereas more managed care-oriented models tend to contain healthcare costs.

Most of these studies that compare and try to explain varying healthcare expenditures at the international level work with the largest possible aggregates of costs (Gerdtham and Jönsson 2000; Martin Martin et al. 2011). This approach seems reasonable because the (sometimes) large differences in the structure of healthcare provision and funding systems in different (Western) countries makes it very difficult to define, construct and compare disaggregated, but cross-nationally still coherent, cost aggregates. However, the agglomeration of largest possible health cost aggregates does not solve the problem that such comparative analyses implicate an increased risk of endogeneity[50] due to unobserved differences across countries.

[50] Endogeneity describes the situation where one or more dependent variables of a regression model (X) are correlated with the error term (ε). The most important causes for endogeneity in a model are the following: 1) omitting relevant regressors that are correlated with independent variable X; 2) simultaneous causality

Furthermore, some studies on regional variations in healthcare costs in Switzerland (Crivelli et al. 2008; Crivelli et al. 2003; Crivelli et al. 2006; Reich et al. 2011; Rüefli and Vatter 2001) have put much effort into creating the broadest possible cost aggregates. Other studies (Camenzind 2008; Schleiniger et al. 2007; Wildi et al. 2005) argue that higher aggregated cost units often compensate one another; therefore, the existing variations being (just) visible in the disaggregated units are more likely to "disappear" statistically. The conclusion drawn from this fact in the present work is that the factors responsible for cost differences should be scrutinized at the highest level of detail.

The research interest in this paper follows the cited literature: it aims to empirically consolidate important factors for varying healthcare utilization on the supply side, the demand side, the financing side, and the political-cultural side of the Swiss healthcare system (Camenzind 2008; Crivelli et al. 2006). On the supply side, it is the link between supply and utilization of healthcare services (Carlsen and Grytten 1998, 2000; Crivelli and Domenighetti 2003b) that can be examined in particular. Because most MHI services in Switzerland are remunerated in a fee-for-service system in the observed time period, and because most service providers have clear incentives to bring their incomes to targeted levels (Busato and Künzi 2008; Crivelli and Domenighetti 2003b; Gosden et al. 2001), it is reasonable to suppose that higher densities of GPs, specialists, hospital beds, and hospital outpatient care services might lead to higher consumption levels in the four corresponding service domains as well as in outpatient medication.

On the demand side, it will be tested whether higher proportions of older people with greater morbidity and mortality (Felder, Meier, and Schmitt 2000), larger population densities indicating urban regions with fewer social barriers to seeing health professionals rather quickly (Schellhorn 2002), and higher unemployment associated with more social deprivation (Marmot 2005) are indeed positively interrelated with the use of MHI health services. Also analyzed is whether higher average income—normally related with better health status, better health behavior, and more supplemental (private) health insurance (Crivelli et al. 2008)—is associated with a decrease in the utilization of MHI health services.

between X and Y; 3) measurement errors in the independent variables; and 4) variable selection biases (see: Antonakis, J., S. Bendahan, P. Jacquart, and R. Lalive. 2010. "On making causal claims: A review and recommendations." *The Leadership Quarterly* 21: 1086 - 120.).

Concerning the financing of health care, this paper attempts to prove empirically whether high deductibles—the standard deductible in MHI is Swiss francs (CHF) 300 by default, but it can be raised to CHF 2,500 in favor of a limited premium reduction and health commodities consumed within one year, and up to these amounts have to be paid out of pocket by policyholders—are interrelated with retained MHI services consumption. One will have to interpret these results with much caution, because the decision for a higher deductible is certainly motivated by relatively high MHI premium levels in the cantons (or the premium regions of the cantons), combined with the knowledge of the individuals about the development of their own health status in the near future. Higher deductibles might also go together with higher out-of-pocket expenditures and more healthcare service utilization outside the MHI.

The other indicator for healthcare financing, the share of alternative health insurance plans—containing institutional requirements and financial incentives such as gatekeeping, limited access to providers, and capitation schemes—is expected to be associated with larger utilization of GPs (Felder et al. 2000; Gosden et al. 2001), more cost-conscious consumption of drugs (Gerfin and Schellhorn 2006), and reduction of the use of specialists, outpatient hospitals, inpatient hospitals, and nursing homes.

With regard to political-cultural variables, the Latin-speaking part of Switzerland[51] is often said to gravitate toward an increased utilization of services of specialists, inpatient hospitals, outpatient hospitals, and higher drug consumption, but with less frequent use of GPs and nursing home services (Crivelli et al. 2008; Crivelli et al. 2006; Rüefli and Vatter 2001). Unfortunately, no time-varying data were available for this indicator, and the variable ultimately could not be used in the applied fixed-effect regressions (see Section 4.2.2).

[51] It is important to notice that the Latin-speaking part of Switzerland has an in average higher population density than the German-speaking part.

4.2 Methods

4.2.1 Data

The main data source for the six dependent variables (see Appendix, Table 13) is "Datenpool santésuisse" (DPS) of the Swiss Association of Health Insurers (santésuisse 2011a). DPS has been in existence since 1997, but the complete sets[52] of quantity (and cost) indicators of MHI services used here have only been recorded every year since 2000. The canton-level analysis conducted here with DPS allows for MHI costs for age and gender groups of the resident (cantonal) population to be related to the different domains of service providers. The latter can be located in the same canton in which the user of the service resides, or they can be situated in another canton. Therefore, the analysis in this article always focuses on the *residential canton* of the healthcare users; whether goods and services used by these residents were provided in their "own" canton or were "imported" from other cantons is not of interest here.

In addition to the costs, DPS also details the quantities of services delivered: the number of consultations (including home visits) of GPs and specialists, the number of consultations in outpatient hospitals, the number of hospital days, the number of days stayed in nursing homes and the costs for drugs. Quantities—and costs for drugs[53]—are calculated per capita (i.e., per capita of the cantonal population). To get these numbers, the average resident populations according to population statistics (ESPOP) (FSO 2011b) of the Swiss Federal Statistical Office (FSO) are used.

DPS and ESPOP statistics are also used to calculate several of the independent variables (see Table 10 for descriptive statistics and Appendix, Table 13 for definitions and sources): the densities of GP (GRU) and of specialists (SPZ), the percentage of outpatient hospital MHI costs compared to the total outpatient MHI costs (PAM), the share of people with deductibles higher than CHF 300 compared to the total number of insured people in the MHI program

[52] DPS contains information only on those people who actually sent their bills to their health insurance provider. Thus, bills that were not sent, for reasons such as a high deductible, are not included in DPS. The actual amount of such "hidden" MHI services and costs are not known.

[53] The missing quantity indicator for consumed drugs (MED) is a minor problem. Because prices for MHI-remunerated drugs are determined by federal authorities on the national level, differences in drug costs can be caused only by differences in consumed quantities or a varying medical use of medicines (Roth, S. and F. Moreau-Gruet. 2011. "Consommation et coûts des médicaments en Suisse entre 1992 et 2009." *Obsan Rapport 50.* Neuchâtel: Swiss Health Obervatory (Obsan).

(FRA), the share of alternative MHI plans compared to the total number of MHI insurance contracts (MOD), and the share of the population over 65 years of age compared to the total population (ALT65). Additionally, the share of the population over 85 years of age (ALT85) is calculated to explain nursing home utilization (Wildi et al. 2005).

ESPOP is also employed as an "auxiliary variable" with three other independent variables: the FSO data sources "Medical Statistics of Hospitals" (MS) (FSO 2011c) to calculate the density of hospital beds (BED), "Areal Statistics" (FSO 2011i) to calculate the population density per canton (POP), and "Statistics of Registered Unemployment" (SECO 2011) produced by the State Secretariat for Economic Affairs (SECO) to calculate the cantonal unemployment rates (ALQ). The cantonal incomes per capita (VEL) come from the "Statistics on National Accounts" (FSO 2011j). Finally, the proportion of the Latin-speaking resident population as a percentage of the resident population with "major language non-German" (LAT) is calculated from the federal population census of 2000 (FSO 2000).

4.2.2 Data analysis

As explained in the background Section, an approach of "identification of influential factors on *disaggregated* target variables" is emphasized in this work. Therefore, individual analyses on the cost "sub-component quantity" of the "subdomains of MHI services" (separately provided by general practitioners, specialist doctors, inpatient hospitals, outpatient hospitals, medication and nursing homes) are performed.

"*Quantity*" delineates the annual number of consultations (including home visits) per capita with GPs (AZG) and specialists (AZS), the annual number of consultations per capita in outpatient hospitals (AMB), the annual number of days per capita in the hospital (HOS), and the annual number of days per capita in nursing homes (SOM). For consumed drugs, annual costs per capita (MED) are used.

As suggested by the literature (see Figure 1), supply-side, demand-side, financing, and political-cultural variables create the influencing factors of the models. Thus, indicators for the four most important suppliers of healthcare services are used (see Table 8). These include the "density of GP" (GRU), the "density of specialists" (SPZ), the "density of hospital beds" (BED), and "proportions of outpatient hospital care" (AMB). The four most cited indicators on the demand side in the literature—more elderly individuals (ALT65), higher average incomes (VEL), larger population densities (POP), and social deprivation (operationalized as higher rates of unemployment (ALQ)[54]) in the canton—are retained in the model.

From the two available financing variables, both the share of low deductibles (FRA) and the share of alternative health insurance plans (MOD) are retained in the models. Finally, a linear trend variable (TRD) that records medical-technical progress and general tendencies for every group of services that are not yet contained in the other explanatory factors is added.

One has to admit that the proposed model in the article misses a precise theoretical foundation (Skinner 2012). The choice of explaining variables was made by a "balanced"[55] selection of the most cited variables in similar Swiss and international studies that were available. As already indicated during the description of the regressors, one price to pay for proceeding in the above manner is its clear risk of introducing *endogeneity* into the regression models. The variables ALQ and FRA, in particular, are merely *proxy* indicators for other phenomena, such as social deprivation or relatively high out-of-pocket expenses. However, as mentioned above, other variables, such as AGE65[56] (cf. AGE85) or POP[57], are "masking" the real causes for the utilization of healthcare services.

Moreover, the observational data[58] used in the models are not randomly assigned to all individuals of the population. They focus only on *users* of the six healthcare provider domains. The consequence of this is what researchers call a "*selection bias problem*" (Heckman 1979), where the right-hand side variables impact the probability of the dependent variable (the probability of healthcare use in the six models). Although, in reality, the whole population has access to healthcare services, only a share of the population actually receives a

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54 Unemployment is in health services research a accepted proxy variable for social deprivation-motivated utilization of healthcare services (see: Fasel, T., N. Baer, and U. Frick. 2010. "Dynamik der Inanspruchnahme bei psychischen Problemen: Soziodemographische, regionale, krankheits- und systembezogene Indikatoren." *Obsan Dossier 13.* Obsan. Neuchâtel: Swiss Health Observatory.).

55 The model is "balanced" (originally 4 supply, 4 demand, 2 funding, and 1 political variables) with respect to the "model of effects" in Figure 1.

56 Higher age is confounded with sex (more women) and related to higher morbidity and mortality (see also the discussion about the "red herring" argument, e.g., Werblow, A., S. Felder, and P. Zweifel. 2007. "Population aging and health care expenditure: a school of 'red herrings'?" *Health Economics* 16(10): 1109-27.).

57 Higher population density (or more urbanity) is, among others, confounded with an shorter average distance to healthcare providers.

58 In an experimental design, one could work with two randomly selected groups (where both groups have an expected value of the dependent variable (e.g., AZG), that is statistically identical for all individuals *before* exposure to the influence variable (e.g., GRU). Here, one could test the *causal* influence of GP density on GP utilization.

treatment[59]. This circumstance makes it more likely to erroneously attribute a causal effect to the variable of influence when comparing the difference between the influenced and the non-influenced groups *after* assignment[60].

Finally, our models open the door for so-called *ecological (inference) fallacies*[61]. An ecological fallacy happens in the interpretation of statistical data wherein inferences about the behavior of individuals are deduced from inference for the group (means) to which those individuals belong. The problem here is even more accentuated, because one cannot work here with *individual* observations on the first level of the analysis. The dependent variables in the model are mean values of age-gender-canton groups that are approximately normally distributed (see Appendix, Figure 11); it is well-known that the individual observations used to calculate these mean values are not (Sommer and Biersack 2006).

With the goal of a simultaneous explanation of the regional variations in levels and the evolution in time of MHI services, panel econometric regressions that combine longitudinal and cross-sectional observations are chosen. The indices "i" for 26 cantons and "t" for eight years give expression to this combination in Formula (1).

$Y_{it} =$ $f\,(GRU_{it}, SPZ_{it}, BED_{it}, PAM_{it}, ALT65/85_{it}, POP_{it}, ALQ_{it}, VEL_{it}, FRA_{it}, MOD_{it}, LAT_{i}, TRD_{t})$;

where: $Y_{it} = AZG_{it}$ or AZS_{it} or HOS_{it} or AMB_{it} or MED_{it} or SOM_{it};

and: $i = 1,2, \ldots, 26$; $t = 2000, 2001, \ldots, 2007$. (1)

59 Even for GPs, with whom the average person in the population consults approximately four consultations annually, not every individual of the population consults a GP every year.

60 If units were not randomly assigned to the groups, such a potential for endogeneity bias can be addressed using instrumental variables. This is an alternative to attempting to identify and control for *all* possible factors that might be correlated with both the regressor and the outcome variable of interest. Instrumental variables must *only* be correlated with the independent variable.

61 An ecological fallacy (or ecological inference fallacy) is a logical fallacy in the interpretation of statistical data where inferences about the nature of individuals are deduced from inference for the group to which those individuals belong (see Kramer, G. H. 1983. "The Ecological Fallacy Revisited: Aggregate- versus Individual-level Findings on Economics and Elections, and Sociotropic Voting." *The American Political Science Review* 77(1): 92-111.).

The statistical examination of the six dependent variables Y_{it} shows that they are distributed in a continuous form[62], normally distributed[63] (see Appendix, Figure 11), and do not contain any outliers; thus, the use of a parametric linear model is appropriate (Bryan 2008). Fixed-effects models (FEMs) and random-effects models (REMs) are suitable for this purpose[64].

REMs make use of variances both within groups and between groups of observations. More information is used in this case; consequently, REMs are generally more efficient than FEMs. However, REMs claim that the panel unit- (i.e., canton-) specific errors and the right-hand-side variables (i.e., regressors) are uncorrelated. If this assumption is violated—basic knowledge about the reality of the federalist Swiss healthcare system makes such non-correlation seem improbable—the REMs become inconsistent[65].

The (less efficient) FEMs have the limitation of only taking into account the variation within groups of observed individuals, which is why the effects of time-invariant variables[66] on dependent variables *cannot* be calculated. FEMs estimate individual cantonal parameters in addition to those of the explanatory variables. Therefore, with limited observations, and to retain as much explanatory power as possible, it makes sense to estimate FEMs by a within-transformation of the model (i.e., adjusting every variable with respect to the cantonal mean). Using the corresponding "FEM-within routine" (Bryan 2008)[67], all coefficients are estimated.

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62 Most of the dependent variables in the model—the number of outpatient consultations or inpatient days per person and year—are count variables on the level of individual persons (and cannot, therefore, be negative, for example). However, because the variables actually used in the model are the calculated annual averages of these frequencies per capita of the cantonal population, a linear model—instead of a statistical count data model—was chosen.

63 To obtain better fit to the normality assumption of the dependent variable, the natural logarithms of HOS (i.e., LHOS) and AMB (i.e., LAMB) were used in the regression equations.

64 Pooled regression models (PRM) for panel data would be theoretically applicable as well. However, because PRMs neglects heterogeneity across observations (by assuming the same coefficients for all observations), those effects unique to each observation are all subsumed in the error terms (ε_{it}). If such treatment is not appropriate, the explanatory variables are no longer uncorrelated with ε_{it}, and the exogeneity assumption is no longer satisfied. Thus, the estimates from pooled OLS regression are biased and inconsistent, and compared to FEM and REM, they are also inefficient.

65 "Consistency" indicates that the estimate regarding the presumed relationship converges to the correct population parameter as the sample size increases (Antonakis, J., S. Bendahan, P. Jacquart, and R. Lalive. 2010. "On making causal claims: A review and recommendations." *The Leadership Quarterly* 21: 1086 - 120.)

66 LAT is dropped from the FEMs.

67 The within-estimator for FEM substracts from every variable in the equation its individual specific mean value. This eliminates the individual effects that are time-invariant in FEM (see previous footnote). The transformed equation can now be calculated using OLS (which again demands strict endogeneity of the regressors).

The Hausman test can be used to check whether FEM *and* REM are consistent (see Appendix, Table 15). For two of the six models (viz., dependent variables AZG and LAMB), the Hausman test indicates that REM estimators are inconsistent; FEMs are preferred in this situation. For three dependent variables (viz., AZS, LHOS, and SOM), the null hypothesis cannot be rejected, and the Hausman test fails for another of the variables (MED). Consequently, to favor consistency versus efficiency, to maintain better comparability between the six estimated models and to respond to theoretical aspects of the (federalist) Swiss healthcare system and to the characteristics of the (observational) data used, it is decided to calculate FEMs alone[68]. F-tests are applied to verify individual and joint linearity of the estimated parameters. All calculations and tests were performed with STATA11® software (see Appendix, Table 14).

Moreover, previous studies (e.g., (Crivelli et al. 2003; Reich et al. 2011)) have used a log-log-transform (i.e., logarithms of all variables on both sides of the regression equation) of the models they are estimating. This approach has the advantage of allowing an elasticity interpretation of the estimated coefficients. In this article, the linear form of the models has been retained, and the coefficients are estimators of the marginal effects of the independent variables.

4.3 Results

Submitting data to the DPS is optional for Swiss health insurance companies; thus, its coverage in 2007 (in 2000) applies "only" to 98 percent (92 percent) of all insured people. To estimate complete values (100 percent), the data are extrapolated using the statistics of the "Common Institution under the Federal Health Insurance Act" (GE-KVG 2011). The "Common Institution" runs the risk equalization system in the MHI; thus, its aggregated indicators cover all insured persons (i.e., the entire Swiss population). The extrapolation assumes that the missing 2 percent (8 percent) of persons in DPS have the same cost structure as the 98 percent (92 percent) of insured people who are included in DPS in 2007 (in 2000). All calculations presented hereafter are based on the extrapolated values of DPS.

[68] See the REM results in Appendix, Table 14.

Table 9 contains different indicators to describe the cantonal differences in levels and growth of the six dependent variables, which cover more than 90 percent of MHI health services (see Table 8). The average annual number of consultations of GP per capita (AZG) between 2000 and 2007 is 3.7, and it varies between 2.3 contacts (cantons Geneva GE and Jura JU) and 4.7 contacts (Glarus GL); this corresponds to an extreme quotient (EQ-)ratio of approximately 1.6. The same indicators for specialists (AZS) are 1.2 (mean) and show fluctuations between 0.7 contacts (Nidwalden NW, Obwalden OW and Uri UR) and 2.1 contacts in Basel-Stadt BS; the EQ for specialist services is greater at 3.2, indicating that larger differences between cantons occur for this domain than for GPs.

Table 9: Dependent variables: levels[1] and trends[2], 2000-2007

MHI service domains: per-capita utilization	n (CANTON[3])	T (YEAR)	N (OBS)	MEAN[4]	STD[4]	MIN[4]	MAX[4]	EQ[4]	Δ percent 2000-2007[2]
General practitioners: consultations (AZG)	26	8	208	3.7	0.5	2.9	4.7	1.6	-0.2 %
Specialist doctors: consultations (AZS)	26	8	208	1.2	0.3	0.7	2.1	3.2	-0.9 %
Inpatient hospital: hospital days (HOS)	26	8	208	1.9	0.5	1.3	3.5	2.7	-0.5 %
Outpatient hospital: consultations (AMB)	26	8	208	0.9	0.5	0.6	2.7	4.5	7.1 %
Outpatient drugs: costs (MED)	26	8	208	420	89	287	572	2.0	3.2 %
Nursing homes: days of stay (SOM)	26	8	208	3.4	1.0	2.2	5.9	2.6	6.6 %

Source: (santésuisse 2011a), calculations by the author.

1) Average absolute numbers of per capita services, days and costs between 2000 and 2007.
2) Average annual growth rates in percent of per capita services, days and costs between 2000 and 2007 (Δ percent 2000-2007).
3) See Figure 2 and the full names and additional characteristics of cantons in Appendix, Table 12.
4) MEAN = arithmetical mean; STD = standard deviation; MIN = minimal value; MAX = maximal value; EQ = extreme quotient = MAX/MIN.

Hospital days (HOS) are 1.9 days per 1,000 persons and year. The cantonal variations range from 1.3 days (Nidwalden NW, Obwalden OW and Zug ZG) to 3.5 days (Basel-Stadt BS), which results in an EQ-ratio of 2.7. The consultations in outpatient hospitals (AMB) are at 0.9 per capita annually. They fluctuate between 0.6 contacts (Schwyz SZ) and 2.7 contacts

(Basel-Stadt BS), and the ratio between these two extreme values is actually 4.5. This is the largest inter-cantonal variation across the six dependent variables.

The average annual costs per capita for outpatient medication (MED) are CHF 420 and range from CHF 287 (Appenzell Innerrhoden AI) to CHF 572 (Basel-Stadt BS), with an EQ-ratio of 2.0. Finally, there is an annual average of 3.4 nursing home days per capita (SOM) remunerated in the MHI program; this number varies between 2.2 (Valais VS) and 5.9 (Appenzell Ausserhoden AR). Here, the result is an EQ-ratio of 2.6.

The last indicator in Table 9 describes the general cantonal trends in the six variables during the observed period of eight years (Δ percent 2000–2007). The tendencies for the utilization of consultations of GPs per capita (AZG; −0.2 percent for the whole country) between 2000 and 2007 are non-uniform: one half of the cantons show rising trends, and the other half show decreasing trends for this indicator. The result is also geographically non-uniform for the utilization of specialists (AZS; −0.9 percent), but particularly large cantons (see Figure 2) show decreasing trends. For the annual number of hospital days per capita (HOS; −0.5 percent), some more cantons with decreasing trends can be found as well.

The other three dependent variables—the consultations in outpatient hospitals (AMB; +7.1 percent), the costs for outpatient medication (MED; +3.2 percent), and the number of nursing home days (SOM; +6.6 percent)—show expanding tendencies across all cantons. There is only one exception from this general trend: in canton Basel-Stadt (BS), the annual number of consultations in outpatient hospitals per capita (AMB) declined from 3.1 in 2000 to 2.5 in 2007 (−3.0 percent annually).

The descriptive statistics of the 12 independent variables in Table 10 are commented upon only very briefly (for information on data sources and definitions, see Appendix, Table 13). The densities of GPs (+0.2 percent annually) and specialists (+1.3) increased, as did the share of outpatient *hospital* costs relative to total outpatient costs (+2.4). The density of hospital beds (-2.4) declined, however. All demand-side variables (ALT65/85, POP, ALQ, and VEL) show increasing trends of +0.2 to +7.5 percent annually between 2000 and 2007. The share of higher deductibles grew by +0.2 percent in the same period, much less than the share of alternative MHI plans at +27.2 percent.

Table 10: Independent variables: descriptive statistics

Independent variables	n (CAN-TON[1])	T (YEAR)	N (OBS)	MEAN[2]	STD[2]	MIN[2]	MAX[2]	EQ[2]	Δ per-cent 2000-2007[3]
Density of general practitioners (GRU)	26	8	208	76.9	9. 8	53.1	101.4	1.9	+0.2 %
Density of specialists (incl. psychiatrists) (SPZ)	26	8	208	35.73	16.3	4.48	89.0	19.9	+1.3 %
Density of hospital beds (BED)	26	8	208	556.9	227.3	219.9	1336.9	6.1	-2.4 %
Share of outpatient hospital costs (PAM)	26	8	208	21.7	2.9	13.8	29.5	2.1	+2.4 %
Population 65+ / 85+) (ALT65 / ALT85)	26 / 26	8 / 8	208 / 208	162.4 / 22.3	19.0 / 4.4	122.4 / 14.1	218.6 / 36.6	1.8 / 2.6	+1.1 % / +2.0 %
Population density (POP)	26	8	208	4.6	9.7	0.3	50.7	194.1	+0.6 %
Unemployment rate (ALQ)	26	8	208	13.6	6.8	1.4	37. 9	27.6	+7.5 %
Average cantonal income (VEL)	26	8	208	10. 8	0.2	10.4	11.7	1.1	+0.2 %
Higher deductibles (FRA)	26	8	208	369.1	104.3	154.0	611.6	4.0	+0.5 %
Alternative MHI-plans (MOD)	26	8	208	93.6	79.5	1.4	338.0	241.9	+27.2 %
Latin-speaking population (LAT)	26	1	26	331.9	348.4	65.0	960.7	14.8	–
Trend variable (linear) (TRD)	1	8	8	7.5	2.3	4	11	2.8	+15.5 %

Sources: see Appendix, Table 13, calculations by the author.

1) See Figure 2 and the full names and more characteristics of cantons in Appendix, Table 12.
2) MEAN = arithmetical mean; STD = standard deviation; MIN = minimal value; MAX = maximal value; EQ = extreme quotient =MAX/MIN.
3) Average annual growth rates in percent between 2000 and 2007 (Δ percent 2000-2007).

Table 11 gives an overview of the results of the multivariate estimates for the six explanatory FEMs (see complete results in Appendix, Table 14). The cantonal and time-related variations of the utilization of GP services per capita (AZG) are significantly and positively linked with higher densities of general practitioners (GRU) and specialists (SPZ), a larger share of outpatient hospital costs (PAM), a greater population density (POP), a higher average cantonal income (VEL), and a larger share of high deductibles (FRA). However, a negative relationship exists between GP utilization and a greater hospital bed density (BED), a higher unemployment rate (ALQ), and more alternative MHI insurance plans (MOD).

Table 11: Multivariate estimation results (FEM and GLS estimators)

Independent Variables \ Dependent Variables	General. practi-tioners consul-tations **AZG**	Specialist doctors consul-tations **AZS**	Inpatient hospitals hospital days **LHOS**	Outpatient hospitals consulta-tions **LAMB**	Outpatient drugs costs **MED**	Nursing homes days of stay **SOM**
Density of general practitioners **GRU**	**0.042***** (0.0036)	**0.002** (0.0022)	**-0.001** (0.0027)	**-0.008**** (0.0036)	**1.379***** (0.4920)	**0.014** (0.0110)
Density of specialist doctors **SPZ**	**0.013***** (0.0038)	**0.020***** (0.0024)	**0.004** (0.0028)	**0.003** (0.0038)	**1.322**** (0.5218)	**-0.016** (0.0112)
Density of hospital beds **BED**	**-0.0001**** (0.0002)	**-0.00007** (0.0001)	**0.0001** (0.0001)	**-0.00004** (0.0002)	**0.022** (0.0257)	**0.001** (0.0005)
Share of outpatient hospital costs **PAM**	**0.012**** (0.0057)	**0.004** (0.0036)	**0.002** (0.0043)	**0.056***** (0.0058)	**-0.935** (0.7881)	**-0.058***** (0.0170)
Population 65+/ 85+[1)] **ALT65 / ALT85***	**0.004** (0.0033)	**0.002** (0.0021)	**-0.001** (0.0005)	**0.010***** (0.0034)	**-0.644** (0.4610)	**0.185*****[1)] (0.0300)
Population density **POP**	**0.259***** (0.0772)	**0.116**** (0.0486)	**-0.037** (0.0582)	**0.216***** (0.0788)	**-22.629**** (10.6982)	**0.071** (0.2287)
Unemployment rate **ALQ**	**-0.019***** (0.0031)	**-0.015***** (0.0020)	**0.007***** (0.0023)	**-0.090***** (0.0032)	**1.348***** (0.4308)	**0.019**** (0.0096)
Average cantonal income **VEL**	**0.390***** (0.1416)	**0.083** (0.089)	**0.143** (0.1067)	**-0.048** (0.1445)	**14.903** (19.6131)	**0.836**** (0.4224)
Share of higher deduc-tibles **FRA**	**0.001***** (0.0004)	**0.001***** (0.0002)	**-0.0001** (0.0027)	**0.002***** (0.0004)	**-0.132***** (0.0487)	**0.004***** (0.0010)
Alternative MHI plans **MOD**	**-0.001**** (0.0004)	**0.0003** (0.0002)	**0.0001** (0.0003)	**-0.0002** (0.0004)	**-0.213***** (0.0511)	**0.0002** (0.0011)
Trend variable **TRD**	**-0.016** (0.0105)	**-0.021***** (0.0066)	**-0.017**** (0.0079)	**0.043***** (0.0107)	**15.121***** (1.4550)	**0.137***** (0.0307)

Source: calculations by the author.
Legend: Standard errors in parentheses. *** Significant at 0.01 percent, ** significant at 0.05 percent omitted = FEM can only estimate coefficients for variables that vary over time.
1) To estimate the utilization of nursing homes, the population 85 years and older is used.

The utilization of more specialist services per capita (AZS) is significantly linked with a higher density of specialists (SPZ), a higher population density (POP), and a larger share of high deductibles (FRA). Otherwise, lower unemployment rates (ALQ) and the trend variable (TRD) accompany reduced utilization of specialists.

The (logarithmic) number of (inpatient) hospital days per capita of population (LHOS) shows one significant positive correlation to the unemployment rate (ALQ) and one significant negative correlation to the trend variable (TRD); the latter expresses the general downward trend in the per-capita utilization of inpatient hospitals.

For the differences in the (logarithmic) quantities of outpatient hospital utilization (LAMB), the estimates show significant positive correlations with larger shares of outpatient hospital services (PAM), older populations (ALT65), higher population densities (POP), more high deductibles (FRA), and the trend variable (TRD). Significant negative associations occur with a greater supply of GPs (GRU) and a higher unemployment rate (ALQ), with all other factors proving themselves to be insignificant.

The variation in drug costs per capita (MED) is highly significant and positively associated with a higher density of GPs (GRU) and specialists (SPZ), the cantonal unemployment rate (ALQ), and the trend variable (TRD). A greater population density (POP), a larger share of high deductibles (FRA), and a larger proportion of alternative MHI plans (MOD) are significantly and negatively related with drug costs per capita (MED).

Finally, the following factors are shown to be significantly and positively related to the per capita differences in nursing home utilization (SOM): a larger share of the population being older than 85 years (ALT85), a higher unemployment rate (ALQ), a higher average cantonal income (VEL), a larger share of high deductibles (FRA), and the general trend (TRD). In contrast, negative interrelations of the utilization of nursing homes per capita (SOM) are found for a greater share of hospital outpatient services (PAM).

4.4 Discussion

The results' Section described how the interplay of the independent variables influences the utilization of every individual domain of MHI services. Due to having used exactly the same set of independent variables for all six models, the perspective can now be changed: the interrelation of every independent variable with the six domains of MHI services can be discussed simultaneously by comparing them across these domains.

Higher densities of general practitioners (GRU) are significantly correlated with greater per capita use of their own services and a higher rate of using drugs. A higher potential supply of specialists (SPZ) is also significantly associated with a more intense use of their own services, more intense utilization of GP services and greater consumption of drugs. No significant positive correlation is found for more hospital beds (BED). Finally, a higher share of hospital outpatient services on total outpatient services (PAM) goes hand in hand with more intense per-capita utilization of such services, including GP services.

Three of the four supply-side variables show one significantly negative predictor. More GPs (GRU) are negatively correlated with the utilization of—relatively expensive—outpatient hospitals. This issue could be further analyzed in terms of stabilizing healthcare costs. Finally, more hospital beds (BED) accompanies less frequent utilization of GPs. The function of GPs warrants their supply for health services in remote areas of the country (i.e., those without hospitals); this circumstance could explain this negative association.

Caution is warranted in directly suspecting that supplier inducement explains the association between higher population-physician ratios and more extensive utilization of medical services (Carlsen and Grytten 1998, 2000; Crivelli and Domenighetti 2003b; Gosden et al. 2001). This relationship could simply reflect an effect of supply response to variations in health status or improved availability. Conversely, in healthcare systems, where service providers are mainly remunerated by fee-for-service schemes and have clear incentives to bring their income to a targeted level, the existence of over-supply and supplier inducement is more probable.

Moreover, effects presented regarding the supply-side factors may partly be an expression of the two different types of cantonal health delivery schemes, as they were described in a former Swiss study using qualitative approaches (Haari et al. 2002). On the one hand, they may show a "center-type scheme", in which high (inpatient and outpatient) hospital and specialist density and use accompany intensive supply and utilization of hospital and specialist services. On the other hand, they may reflect the "peripheral-type scheme" of a cantonal health system, which is more focused on primary care and nursing homes, in which supply and utilization of specialists and hospital services are restrained.

Significant positive associations between the use of healthcare providers and all four tested factors on the demand side are found. Higher age (ALT65 or ALT85) is interrelated with more intense utilization of outpatient hospitals and nursing homes. This result makes sense in the nursing home branch, but the relationship between higher age and more intense outpatient hospital utilization is rather unexpected[69]. Higher population densities (POP) are positively correlated with more intense utilization of both types of physicians and with outpatient

[69] Higher age was introduced as being correlated with greater morbidity and mortality, as well as with gender (more women). Moreover, it is correlated with higher population density.

hospitals; proximity to providers and fewer social barriers in urban areas to seeing a health professional quickly might be responsible for this as well. High unemployment (ALQ), a proxy variable for more people living in difficult economic or social conditions, is positively associated with the consumption of drugs and with more frequent or longer stays in hospitals and nursing homes. Finally, a higher average cantonal income (VEL) is significantly positive correlated with higher levels of utilization of per capita GP services and nursing homes. The problem of ecological fallacy (see paragraph 4.2.2) seems to be present here (see also the following paragraph).

Among the demand-side variables, the “proxy indicator” for deprivation, the unemployment rate (ALQ), shows significant negative interrelations with per capita *outpatient* consultations with GPs, specialists, and hospitals. This result is certainly “polluted” by ecological fallacy. The financial difficulties of individuals living in impoverished circumstances, could still explain partly this finding and merits special attention. It could suggest that poorer people avoid *outpatient* treatments but go through greater drug consumption and more or longer unavoidable stays in hospitals or nursing homes. An undersupply of such groups of vulnerable people in the outpatient sector (Bisig and Gutzwiler 2004) could have serious medical, social, and financial consequences.

The negative association between the population density (POP) and the costs for outpatient pharmaceutical treatment per capita was unexpected. Ignoring the ecological fallacy, an explanation could be that a higher number of (outpatient) hospital activities in urban areas partially substitute provision of drugs delivered by pharmacies and physicians—i.e., which would otherwise be contained in the indicator MED. It could also indicate that people in urban areas show a tendency to pay more out of pocket for drugs, particularly in combination with higher deductibles.

Regarding the two indicators of health services financing, one would expect slowing effects from higher deductibles (FRA) on all domains of health services. However, as indicated earlier in the article, the interrelation of FRA with the dependent variables is problematic in different ways: FRA “masks” other (omitted) variables, is exposed to a selection bias, and makes committing an ecological fallacy very probable. Keeping this in mind, the results in Table 11 show that higher deductibles actually correspond to *more* intense utilization of GPs

(GRU), specialists (SPZ), outpatient hospital services (PAM), and nursing homes (SOM), but lower medication costs per capita (MED).

Slowing effects could also be expected by greater availability of alternative MHI plans (MOD) in the population for all health service provider domains, except for GPs given their coordination functions in alternative MHI plans (Seematter-Bagnoud et al. 2008). In fact, a negative association between more MOD and GP utilization (AZG), as well as for outpatient drugs (MED), is found. Therefore, the assumption of higher utilization because of the coordination function of GPs in such plans is not confirmed, which could connect to the limitation that only the frequencies of contacts are measured in the models. Better coordination by GPs does *not* necessarily mean more *frequent* use of the services of this domain of providers.

The trend variables (TRD) can explain additional variance of the dependent variables in the six models. The results obtained for TRD in Table 11 seem reasonable: increasing trends observed in the descriptive statistics (see Table 9) for hospital outpatient services (AMB), drugs (MED), and nursing homes (SOM) are again visible in the significantly positive coefficients attached to the regression results of LAM, MED, and SOM. The same is true for the declining trends in inpatient hospital utilization (LHOS) and the per capita use of specialists (AZS) and GPs (AZG, not significant).

Whereas declining trends for GP and inpatient hospital utilization are broadly expected in Switzerland (Wildi et al. 2005), most people would not expect such a reduction for specialist doctors who have constantly rising costs. However, this finding can be further explained with a limitation in the dependent "quantity" variables. Because one can only count the number of consultations in the outpatient sector (and the number of days in the inpatient sector), changes in medical practices (Borowitz 2010; OECD 2011b) that occur across cantons and over time cannot be seen. Thus, for specialist doctors in Switzerland, there exists a trend toward *fewer* (but more intense) consultations per capita during the observed time period.

4.5 Conclusions

The new and impactful points in this work are as follows: differences in healthcare utilization in space and time are investigated on a detailed level—quantity indicators for six individual service domains within MHI. At the same time, the variation in these detailed six variables is tested with an identical set of 12 influence factors that represent explanatory models containing supply-side, demand-side, and financing-side variables. The testing of such a constant set of 12 explanation variables across the six models allows a bidirectional interpretation of the results. In addition to understanding how each of the six target variables is interrelated with the whole set of regressors, one can learn more about how each individual influence factor is associated with all six healthcare service domains.

Concerning *methodology*, larger problems appeared during the analysis: one important methodological problem is the obvious existence of *endogeneity* in the regression models, caused by omitted variables and selection bias. In addition to refraining from the use of REM, the results for the six FEMs are limited in the sense that *no direct causal inferences* for any individual regressor should be made in such a situation. This circumstance is particularly true for regressors such as ALQ and FRA, where the endogeneity problem is most obvious. Another important problem comes from the fact that one *cannot* work with individual observations on the first level of the analysis. The dependent variables in the model are *mean values* of age-gender-canton groups that are approximately normally distributed. However, the *individual observations* used to calculate these mean values are not at all normally distributed.

Concerning *data,* the article also could have been better in a few ways: a closer look at more detailed domains of health service providers, such as different types of hospitals or different types of outpatient specialists, could have been possible. With respect to the spatial dimension, analyses of variations on a more detailed level as well—e.g., at the level of districts or even municipalities in Switzerland—could have been productive. However, the lack of access to these types of disposable data did not allow this. Primarily for data protection reasons, DPS only aggregates patients by age-group, gender, and *canton,* leading to the consequences mentioned above. As a result, *individual* data sources on healthcare service utilization, including the sociodemographic characteristics[70] of patients, would certainly allow further validation of the results of this article.

The findings of this paper confirm that consumption and cost-containment strategies in health care should integrate several supply-side, demand-side, and financing elements (Camenzind 2008). First, the cantonal structure of the *healthcare supply* system seems to be a crucial element. High densities of healthcare suppliers are interrelated—at least in their combination with fee-for-service remuneration, target incomes, and contracting obligation for insurers—in more intense utilization per capita of most domains of healthcare services and in greater drug consumption (Gosden et al. 2001). Whether or not this happens through supplier-induced demand, health policy authorities should be made aware of this fact.

Among these supply-side elements, special attention should be paid to the growing amounts of relatively expensive *outpatient hospital services* (Strunk, Ginsburg, and Gabel 2002)[71]. The results in the models show that higher densities of GPs might have a negative correlation with hospital outpatient use, thereby suggesting that a geographically well-distributed supply of primary care services is important. Moreover, it seems that a greater supply of specialized and relatively costly outpatient healthcare services might be associated with a lower intensity of nursing home utilization (Norton 2000). What is beneficial for older patients, who normally try to avoid institutionalization (with its relatively large out-of-pocket and relatively small MHI funding in Switzerland) as long as possible, can cause more costs elsewhere in the MHI.

Furthermore, the extent of potentially drivers of healthcare services and costs on the demand side—viz., aging population, urbanization, and social deprivation of certain groups appearing together with rising average incomes (i.e., greater economic inequalities)—seem to contribute to regional variations in consumption and costs of healthcare services. Political strategies to counter such factors could be developed on the cantonal or national levels. Many other political and social areas would benefit from the development of an active strategy against problems including social isolation, poverty, unemployment, educational deficits, and language deficits.

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70 Among other advantages, this would reduce the problem of committing "ecological fallacies."

71 Compared to the health services provided by physicians in medical practices, the production process for a given health problem in outpatient hospitals is considered to be at relatively great expense. However, it is possible that the price (i.e., the TARMED taxpoint value in Switzerland) for an identical individual service item is higher for medical practices than for oupatient hospitals (e.g., in canton Ticino).

Appendix, Chapter 4

- **List of abbreviations used (see Table 12 for the acronyms of the Swiss cantons and Table 13 for the acronyms of the tested variables)**

MHI: mandatory health insurance; GP: General practitioner; FEM: fixed-effects regression models; REM: random-effects regression models; PRN: pooled-regression models; DPS: Datenpool santésuisse; ESPOP: Swiss population statistics; FSO: Swiss Federal Statistical Office; MS: Swiss medical statistics of hospitals; AVAM: labor placement and statistics system; SECO: Swiss state secretariat for economic affairs; VZ 2000: Swiss population census 2000; CHF: Swiss francs.

• Additional Tables and Figures

Table 12: Swiss cantons: an overview

Name of cantons	Acronyms	Surface area[1] in km²	Population in million persons[2] (2009)	Population density (persons per km²)	Resources index[3] 2004/2005	MHI costs per capita[4] 2007
Aargau	AG	1,404	0.600	427	87.8	2,167
Appenzell Innerrhoden	AI	173	0.016	93	82.7	1561
Appenzell Ausserhoden	AR	243	0.053	218	79.8	1,869
Bern	BE	5,959	0.974	163	74.0	2,663
Basel-Landschaft	BL	518	0.273	363	110.2	2,508
Basel-Stadt	BS	37	0.188	7,378	148.6	3,291
Fribourg	FR	1,671	0.273	163	74.9	2,286
Geneva	GE	282	0.453	1,604	155.4	3,238
Glarus	GL	685	0.039	57	96.1	2,032
Graubünden	GR	7,105	0.192	27	84.9	2,141
Jura	JU	839	0.070	83	66.5	2,450
Lucerne	LU	1,493	0.373	250	77.0	2,026
Neuchâtel	NE	803	0.172	214	91.0	2,577
Nidwalden	NW	276	0.041	149	124.6	1,862
Obwalden	OW	491	0.035	71	67.0	1,937
St. Gallen	SG	2,026	0.475	235	77.0	1,993
Schaffhausen	SH	298	0.076	255	92.9	2,301
Schwyz	SZ	790	0.145	183	75.8	2,381
Solothurn	SO	908	0.253	279	135.6	2,027
Thurgau	TG	991	0.245	247	76.5	2,070
Ticino	TI	2,812	0.336	119	102.8	2,892
Uri	UR	1,077	0.035	33	67.0	1,991
Vaud	VD	3,212	0.702	219	96.7	2,777
Valais	VS	5,224	0.307	59	61.6	2,216
Zug	ZG	239	0.111	465	204.0	2,019
Zurich	ZH	1,729	1.351	781	132.1	2,381
Switzerland	**CH**	**41,285**	**7.786**	**189**	**100.0**	**2,443**

1) Source: (FSO 2011i).
2) Source: (FSO 2011b).
3) The resources index is an indicator for the financial power of a canton calculated from the amount of tax revenues per capita of the cantonal population. (see Eidgenössische Finanzverwaltung, Verordnung vom 7.11.2007 über den Finanz- und Lastenausgleich (FiLaV, SR 613.21, http://www.admin.ch/ch/d/sr/6/613.21.de.pdf).
4) Source: (santésuisse 2011a).

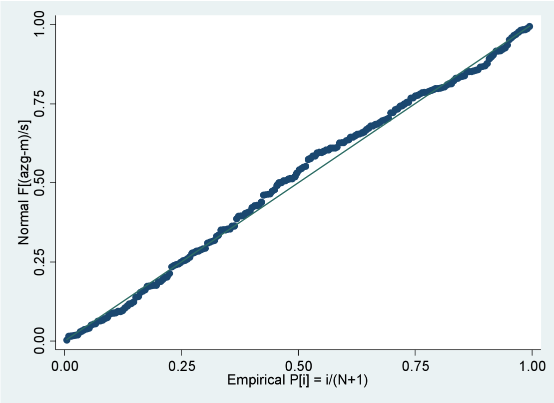
Table 13: Dependent and independent variables

Variables tested	Acronym	Sources[1] (Institution)	Years	Definition
Dependent Variables				
General practitioners (GP): consultations	**AZG**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI consultations (GP) per capita [2]
Specialist doctors: consultations	**AZS**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI consultations (specialists) per capita
Inpatient hospitals: hospital days	**HOS**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI hospital days (inpatient) per capita
Outpatient hospitals: consultations	**AMB**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI consultations (outpatient) per capita
Outpatient drugs: costs	**MED**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI costs[3] for drugs (outpatient) per capita in CHF
Nursing homes: days of stay	**SOM**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	MHI days of care (nursing homes)[4] per capita
Independent Variables				
Supply-side				
Density of general practitioners (GP)	**GRU**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	Number of GP (equivalents full-time) per 100,000 population
Density of specialists (including psychiatrists)	**SPZ**	DPS / ESPOP (santésuisse / FSO)	2000 – 2007	Number of specialists (equivalents full-time) per 100,000 population
Density of hospital beds	**BED**	MS / ESPOP (FSO)	2000 – 2007	Number of beds (K11 +12 +21 +22 +23) per 100,000 population
Share of hospital outpatient costs	**PAM**	DPS (santésuisse)	2000 – 2007	MHI share of costs hospital outpatient on total outpatient costs CHI
Demand-side				
Population 65+/85+	**ALT65 / ALT85**	ESPOP (FSO)	2000 – 2007	Share of people 65+ / 85+ years per 1,000 population
Population density	**POP**	Areal statistics / ESPOP (FSO)	2000 – 2007	Number of inhabitants per canton (persons per hectare)
Unemployment rate	**ALQ**	AVAM / ESPOP (SECO / FSO)	2000 – 2007	Registered unemployed persons (Ø year) per 1,000 population
Average cantonal income[5]	**VEL**	Statistics on National Accounts (FSO)	1998 – 2005	Log. transform. of cantonal income[6] per capita of population in CHF
Financing				
Higher deductibles	**FRA**	DPS (santésuisse)	2000 – 2007	MHI share of insured with deductible > CHF 300 on total of 1,000 insured
Alternative MHI-plans	**MOD**	DPS (santésuisse)	2000 – 2007	MHI share of insured alternative plans on total of 1,000 insured
Politics / various				
Latin-speaking population	**LAT**	VZ 2000 (FSO)	2000	Share of primary language “non-German” per 1,000 population
Trend variable (linear)	**TRD**	-	2000 - 2007	2000 = 1, 2001 = 2, etc.

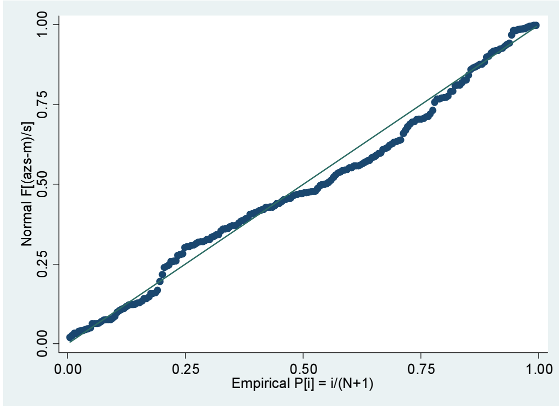
1) Sources: (FSO 2000, 2011b, 2011c, 2011i, 2011j; santésuisse 2011a; SECO 2011)
2) Residence rule: utilization of providers located in the same canton or of providers located in other cantons by the resident population of the canton.
3) Drugs are administered by outpatient physicians and pharmacies.
4) Total social-medical institutions (for the elderly, the chronically ill, and disabled individuals).
5) After checking the distributional characteristics of all dependent and independent variables, it was decided to transform the average cantonal income per capita (VEL) into its logarithmic form.
6) Per capita sum of income that residential units (private households, firms, public households) of a canton receive for their productive activity for the economy inside or outside the canton.

Figure 11: Normality tests of the dependent variables AZG, AZS, LHOS, LAMB, MED, and SOM

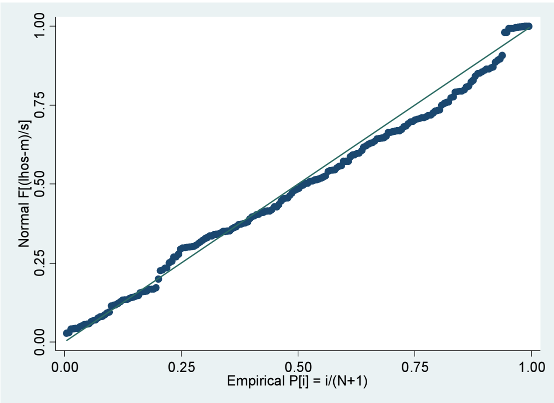
pnorm AZG



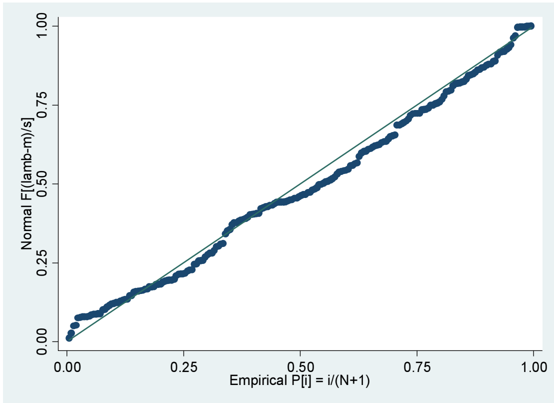
pnorm AZS



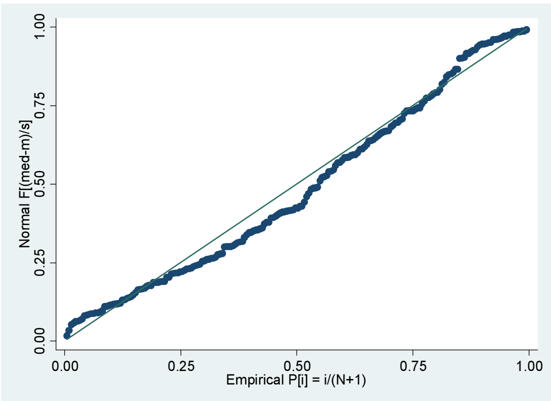
pnorm LHOS



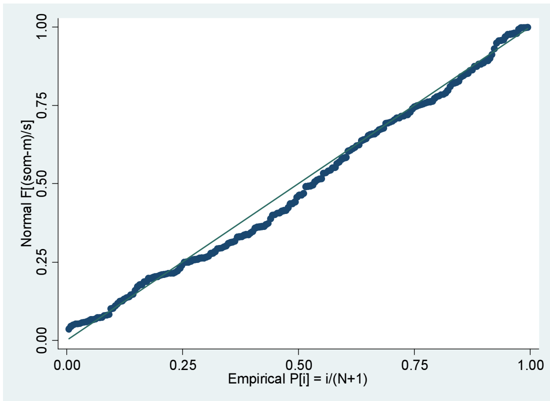
pnorm LAMB



pnorm MED



pnorm SOM



Source: Source: (santésuisse 2011a).; calculations by the author.

Table 14: Detailed results of the multivariate estimation results: fixed effects (fe) and random effects (re) models for AZG, AZS, LHOS, LAMB, MED, and SOM

```
xtreg azg gru spz bed pam alt65 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.7215                         Obs per group: min =         8
       between = 0.0024                                        avg =       8.0
       overall = 0.0038                                        max =         8
                                                F(11,171)          =     40.28
corr(u_i, Xb)  = -0.9823                        Prob > F           =    0.0000
------------------------------------------------------------------------------
         azg |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0418876   .0035522    11.79   0.000     .0348759    .0488994
         spz |   .0134024    .003767     3.56   0.000     .0059667    .0208382
         bed |  -.0004486   .0001859    -2.41   0.017    -.0008155   -.0000817
         pam |   .0116055   .0056899     2.04   0.043     .0003741    .0228369
       alt65 |   .0038879   .0033285     1.17   0.244    -.0026824    .0104581
         pop |   .2585142   .0772388     3.35   0.001     .1060499    .4109785
         alq |  -.0185646   .0031104    -5.97   0.000    -.0247044   -.0124249
         vel |   .3899042   .1416027     2.75   0.007     .1103899    .6694186
         fra |   .0012681   .0003519     3.60   0.000     .0005735    .0019627
         mod |  -.0009535   .0003691    -2.58   0.011    -.0016822   -.0002249
         lat |  (omitted)
         trd |  -.0160249   .0105046    -1.53   0.129    -.0367603    .0047105
       _cons |   -6.01164   1.568309    -3.83   0.000    -9.107378   -2.915901
-------------+----------------------------------------------------------------
     sigma_u |  2.7179603
     sigma_e |  .09900062
         rho |  .99867501   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    42.68             Prob > F = 0.0000


xtreg azg gru spz bed pam alt65 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.6975                         Obs per group: min =         8
       between = 0.6614                                        avg =       8.0
       overall = 0.6588                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =    417.29
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
         azg |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0410743   .0032251    12.74   0.000     .0347532    .0473955
         spz |   .0066046   .0034101     1.94   0.053     -.000079    .0132882
         bed |  -.0002446   .0001739    -1.41   0.159    -.0005854    .0000961
         pam |   .0099005   .0058625     1.69   0.091    -.0015897    .0213907
       alt65 |   .0070761   .0025977     2.72   0.006     .0019848    .0121675
         pop |  -.0090607   .0070614    -1.28   0.199    -.0229008    .0047793
         alq |  -.0145792   .0030327    -4.81   0.000    -.0205232   -.0086353
         vel |   .3477151   .1291551     2.69   0.007     .0945757    .6008544
         fra |    .000902   .0003366     2.68   0.007     .0002422    .0015617
         mod |  -.0007522   .0003624    -2.08   0.038    -.0014626   -.0000418
         lat |  -.0008229    .000193    -4.26   0.000    -.0012011   -.0004446
         trd |  -.0171358   .0099782    -1.72   0.086    -.0366926    .0024211
       _cons |   -4.25949   1.471093    -2.90   0.004    -7.142778   -1.376201
-------------+----------------------------------------------------------------
     sigma_u |   .2649882
     sigma_e |  .09900062
         rho |  .87751638   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
xtreg azs gru spz bed pam alt65 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.6800                         Obs per group: min =         8
       between = 0.5833                                        avg =       8.0
       overall = 0.5524                                        max =         8
                                                F(11,171)          =     33.04
corr(u_i, Xb)  = -0.9811                        Prob > F           =    0.0000
------------------------------------------------------------------------------
         azs |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0021977   .0022334     0.98   0.327     -.002211    .0066063
         spz |   .0202506   .0023685     8.55   0.000     .0155753    .0249258
         bed |   -.000071   .0001169    -0.61   0.545    -.0003016    .0001597
         pam |   .0038578   .0035775     1.08   0.282     -.003204    .0109196
       alt65 |   .0023832   .0020928     1.14   0.256    -.0017478    .0065143
         pop |    .116347    .048564     2.40   0.018     .0204848    .2122092
         alq |  -.0152459   .0019557    -7.80   0.000    -.0191062   -.0113855
         vel |   .0833328   .0890329     0.94   0.351    -.0924124    .2590779
         fra |   .0013068   .0002212     5.91   0.000     .0008701    .0017435
         mod |   .0003101   .0002321     1.34   0.183     -.000148    .0007682
         lat |  (omitted)
         trd |  -.0209927   .0066048    -3.18   0.002    -.0340301   -.0079553
       _cons |   -1.67962   .9860771    -1.70   0.090    -3.626071    .2668315
-------------+----------------------------------------------------------------
     sigma_u |   1.161147
     sigma_e |  .06224681
         rho |  .99713441   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    20.05             Prob > F = 0.0000


xtreg azs gru spz bed pam alt65 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.6594                         Obs per group: min =         8
       between = 0.8769                                        avg =       8.0
       overall = 0.8580                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =    523.13
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
         azs |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0035493   .0016939     2.10   0.036     .0002293    .0068692
         spz |   .0179159   .0017924    10.00   0.000      .014403    .0214289
         bed |   .0001633   .0000951     1.72   0.086    -.0000232    .0003498
         pam |    .000259   .0035082     0.07   0.941     -.006617     .007135
       alt65 |    .000894   .0012578     0.71   0.477    -.0015713    .0033593
         pop |   .0004654   .0030521     0.15   0.879    -.0055166    .0064474
         alq |  -.0135017   .0017584    -7.68   0.000    -.0169481   -.0100552
         vel |   .0991667   .0679205     1.46   0.144    -.0339551    .2322885
         fra |   .0010549   .0001927     5.48   0.000     .0006773    .0014325
         mod |   .0003776    .000204     1.85   0.064    -.0000222    .0007774
         lat |  -.0000548   .0000828    -0.66   0.508     -.000217    .0001074
         trd |  -.0140069   .0055643    -2.52   0.012    -.0249127   -.0031011
       _cons |  -1.114498   .7810555    -1.43   0.154    -2.645339    .4163425
-------------+----------------------------------------------------------------
     sigma_u |  .10195682
     sigma_e |  .06224681
         rho |  .72847203   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
xtreg lhos gru spz bed pam alt65 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.1750                         Obs per group: min =         8
       between = 0.2329                                        avg =       8.0
       overall = 0.1931                                        max =         8
                                                F(11,171)          =      3.30
corr(u_i, Xb)  = -0.9017                        Prob > F           =    0.0004
------------------------------------------------------------------------------
        lhos |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   -.001152   .0026774    -0.43   0.668    -.0064371    .0041332
         spz |   .0037698   .0028394     1.33   0.186     -.001835    .0093745
         bed |   .0001374   .0001401     0.98   0.328    -.0001392    .0004139
         pam |   .0018571   .0042888     0.43   0.666    -.0066086    .0103229
       alt65 |  -.0005237   .0025089    -0.21   0.835    -.0054761    .0044286
         pop |  -.0369658   .0582189    -0.63   0.526    -.1518861    .0779544
         alq |   .0072861   .0023445     3.11   0.002     .0026583     .011914
         vel |   .1432328   .1067333     1.34   0.181    -.0674518    .3539173
         fra |   .0001171   .0002652     0.44   0.659    -.0004064    .0006407
         mod |   .0001409   .0002782     0.51   0.613    -.0004083    .0006902
         lat |  (omitted)
         trd |   -.017481   .0079179    -2.21   0.029    -.0331104   -.0018517
       _cons |  -.8764016   1.182116    -0.74   0.459    -3.209821    1.457018
-------------+----------------------------------------------------------------
     sigma_u |  .45472293
     sigma_e |  .07462193
         rho |  .97377604   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    11.79             Prob > F = 0.0000


xtreg lhos gru spz bed pam alt65 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.1349                         Obs per group: min =         8
       between = 0.7884                                        avg =       8.0
       overall = 0.7180                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =    110.91
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        lhos |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0009023   .0018183     0.50   0.620    -.0026616    .0044662
         spz |   .0009728   .0019231     0.51   0.613    -.0027964     .004742
         bed |   .0001607   .0001046     1.54   0.124    -.0000442    .0003657
         pam |   .0004262   .0040339     0.11   0.916    -.0074802    .0083325
       alt65 |   .0051321   .0013091     3.92   0.000     .0025664    .0076978
         pop |   .0029516   .0031079     0.95   0.342    -.0031399     .009043
         alq |   .0081571   .0019925     4.09   0.000      .004252    .0120623
         vel |   .0597786   .0727087     0.82   0.411    -.0827279    .2022851
         fra |  -.0000655   .0002164    -0.30   0.762    -.0004897    .0003586
         mod |   .0002001   .0002263     0.88   0.376    -.0002433    .0006436
         lat |   .0001042   .0000843     1.24   0.216    -.0000611    .0002695
         trd |  -.0258708   .0061853    -4.18   0.000    -.0379939   -.0137477
       _cons |  -1.040902   .8385915    -1.24   0.215    -2.684511    .6027072
-------------+----------------------------------------------------------------
     sigma_u |  .10025233
     sigma_e |  .07462193
         rho |  .64348256   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
xtreg lamb gru spz bed pam alt65 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.8196                         Obs per group: min =         8
       between = 0.6577                                        avg =       8.0
       overall = 0.4975                                        max =         8
                                                F(11,171)          =     70.64
corr(u_i, Xb)  = -0.9919                        Prob > F           =    0.0000
------------------------------------------------------------------------------
        lamb |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |  -.0081572   .0036249    -2.25   0.026    -.0153127   -.0010018
         spz |   .0025811   .0038442     0.67   0.503     -.005007    .0101693
         bed |   .0000404   .0001897     0.21   0.832     -.000334    .0004148
         pam |   .0564835   .0058065     9.73   0.000      .045022    .0679451
       alt65 |   .0096344   .0033967     2.84   0.005     .0029295    .0163393
         pop |   .2161235   .0788214     2.74   0.007     .0605352    .3717118
         alq |  -.0189968   .0031741    -5.98   0.000    -.0252623   -.0127312
         vel |  -.0478249   .1445042    -0.33   0.741    -.3330665    .2374168
         fra |   .0015754   .0003591     4.39   0.000     .0008665    .0022842
         mod |   .0000213   .0003767     0.06   0.955    -.0007222    .0007649
         lat |  (omitted)
         trd |   .0429393   .0107199     4.01   0.000      .021779    .0640996
       _cons |  -3.559731   1.600444    -2.22   0.027    -6.718902   -.4005604
-------------+----------------------------------------------------------------
     sigma_u |  1.9907066
     sigma_e |  .10102916
         rho |  .99743101   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    13.70             Prob > F = 0.0000


xtreg lamb gru spz bed pam alt65 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.8018                         Obs per group: min =         8
       between = 0.7500                                        avg =       8.0
       overall = 0.7607                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =    748.34
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        lamb |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |  -.0025789   .0026336    -0.98   0.327    -.0077406    .0025829
         spz |   .0021997   .0027858     0.79   0.430    -.0032604    .0076598
         bed |   .0002553   .0001501     1.70   0.089    -.0000389    .0005495
         pam |   .0481411   .0056932     8.46   0.000     .0369826    .0592995
       alt65 |   .0066271   .0019168     3.46   0.001     .0028701     .010384
         pop |   .0152953   .0045817     3.34   0.001     .0063154    .0242753
         alq |  -.0141545   .0028272    -5.01   0.000    -.0196957   -.0086134
         vel |   .0397545   .1054437     0.38   0.706    -.1669113    .2464202
         fra |   .0010564   .0003081     3.43   0.001     .0004525    .0016603
         mod |   .0003421   .0003238     1.06   0.291    -.0002925    .0009766
         lat |   .0000835   .0001242     0.67   0.502      -.00016     .000327
         trd |   .0481895   .0088395     5.45   0.000     .0308645    .0655145
       _cons |  -3.407736   1.214923    -2.80   0.005    -5.788941   -1.026532
-------------+----------------------------------------------------------------
     sigma_u |  .14587274
     sigma_e |  .10102916
         rho |  .67582505   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
xtreg med gru spz bed pam alt65 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.8519                         Obs per group: min =         8
       between = 0.1829                                        avg =       8.0
       overall = 0.1204                                        max =         8
                                                F(11,171)          =     89.44
corr(u_i, Xb)  = -0.9463                        Prob > F           =    0.0000
------------------------------------------------------------------------------
         med |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   1.378749   .4920021     2.80   0.006     .4075694    2.349929
         spz |   1.321651   .5217574     2.53   0.012     .2917364    2.351566
         bed |   .0220579   .0257445     0.86   0.393    -.0287601    .0728759
         pam |  -.9348937   .7880914    -1.19   0.237    -2.490534    .6207467
       alt65 |  -.6441417   .4610244    -1.40   0.164    -1.554173      .26589
         pop |   -22.6289   10.69818    -2.12   0.036    -43.74639   -1.511405
         alq |   1.348102   .4308164     3.13   0.002     .4976988    2.198505
         vel |   14.90346   19.61308     0.76   0.448    -23.81146    53.61838
         fra |  -.1324062   .0487381    -2.72   0.007    -.2286119   -.0362004
         mod |  -.2132569   .0511291    -4.17   0.000    -.3141823   -.1123315
         lat |  (omitted)
         trd |    15.1214   1.454971    10.39   0.000     12.24939    17.99342
       _cons |   261.0969    217.223     1.20   0.231     -167.687    689.8808
-------------+----------------------------------------------------------------
     sigma_u |  260.42331
     sigma_e |  13.712357
         rho |  .99723521   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    20.75             Prob > F = 0.0000


xtreg med gru spz bed pam alt65 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.8334                         Obs per group: min =         8
       between = 0.8652                                        avg =       8.0
       overall = 0.8610                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =   1023.40
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
         med |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .9471212   .3994433     2.37   0.018     .1642268    1.730016
         spz |   1.364308   .4227078     3.23   0.001     .5358162      2.1928
         bed |  -.0163581    .022289    -0.73   0.463    -.0600438    .0273276
         pam |  -.6769937   .8110909    -0.83   0.404    -2.266703    .9127153
       alt65 |   .6405659   .2996403     2.14   0.033     .0532816     1.22785
         pop |   1.717353   .7337674     2.34   0.019     .2791955    3.155511
         alq |   1.762917   .4083524     4.32   0.000     .9625608    2.563273
         vel |   3.463371   16.02272     0.22   0.829    -27.94058    34.86732
         fra |  -.0403764   .0448412    -0.90   0.368    -.1282635    .0475107
         mod |   -.116167   .0476307    -2.44   0.015    -.2095214   -.0228125
         lat |   .1312491   .0199025     6.59   0.000      .092241    .1702572
         trd |   10.67425   1.299501     8.21   0.000     8.127272    13.22122
       _cons |   51.66802   184.0607     0.28   0.779    -309.0843    412.4203
-------------+----------------------------------------------------------------
     sigma_u |  23.897383
     sigma_e |  13.712357
         rho |  .75230489   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

```
xtreg som gru spz bed pam alt85 pop alq vel fra mod lat trd, fe
note: lat omitted because of collinearity
Fixed-effects (within) regression               Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.7672                         Obs per group: min =         8
       between = 0.1562                                        avg =       8.0
       overall = 0.2238                                        max =         8
                                                F(11,171)          =     51.23
corr(u_i, Xb)  = -0.7378                        Prob > F           =    0.0000
------------------------------------------------------------------------------
         som |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |   .0136964    .011014     1.24   0.215    -.0080445    .0354374
         spz |  -.0158793   .0112088    -1.42   0.158    -.0380047     .006246
         bed |   .0005268   .0005474     0.96   0.337    -.0005537    .0016074
         pam |  -.0584322   .0169821    -3.44   0.001    -.0919538   -.0249106
       alt85 |   .1847287   .0300356     6.15   0.000     .1254405     .244017
         pop |   .0711415   .2286573     0.31   0.756    -.3802129    .5224958
         alq |   .0189382   .0095521     1.98   0.049     .0000829    .0377934
         vel |   .8360026   .4224486     1.98   0.049      .002117    1.669888
         fra |   .0038857   .0010319     3.77   0.000     .0018489    .0059225
         mod |   .0002489   .0011077     0.22   0.822    -.0019376    .0024354
         lat |  (omitted)
         trd |   .1369511   .0307237     4.46   0.000     .0763046    .1975976
       _cons |  -12.30743   4.682011    -2.63   0.009    -21.54941   -3.065454
-------------+----------------------------------------------------------------
     sigma_u |  1.3115911
     sigma_e |  .29540486
         rho |  .95172209   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 171) =    19.68             Prob > F = 0.0000


xtreg som gru spz bed pam alt85 pop alq vel fra mod lat trd, re
Random-effects GLS regression                   Number of obs      =       208
Group variable: reg                             Number of groups   =        26
R-sq:  within  = 0.7652                         Obs per group: min =         8
       between = 0.6851                                        avg =       8.0
       overall = 0.7075                                        max =         8
Random effects u_i ~ Gaussian                   Wald chi2(12)      =    615.12
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
         som |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gru |    .020164   .0081009     2.49   0.013     .0042866    .0360414
         spz |  -.0225219   .0086087    -2.62   0.009    -.0393945   -.0056492
         bed |   .0009177   .0004342     2.11   0.035     .0000666    .0017688
         pam |  -.0595905   .0159483    -3.74   0.000    -.0908486   -.0283325
       alt85 |   .1748434   .0217513     8.04   0.000     .1322117    .2174751
         pop |  -.0253544   .0158925    -1.60   0.111    -.0565032    .0057944
         alq |   .0197508   .0083428     2.37   0.018     .0033992    .0361024
         vel |   .7145723   .3265637     2.19   0.029     .0745193    1.354625
         fra |   .0029802   .0008849     3.37   0.001     .0012458    .0047146
         mod |   6.56e-06   .0009527     0.01   0.995    -.0018606    .0018738
         lat |  -.0015082    .000429    -3.52   0.000     -.002349   -.0006675
         trd |    .152803   .0254548     6.00   0.000     .1029125    .2026935
       _cons |  -10.05462   3.662627    -2.75   0.006    -17.23324   -2.876006
-------------+----------------------------------------------------------------
     sigma_u |  .58610949
     sigma_e |  .29540486
         rho |  .79743178   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Table 15: Correlation matrix of regressors and the results of the Hausman tests (dependent variables: AZG, AZS, LHOS, LAMB, MED, and SOM)

```
corr   gru spz bed pam alt65 vel pop alq fra mod trd (obs=208)
      |    gru    spz     bed    pam     alt65     vel    pop     alq     fra      mod    trd
------+-------------------------------------------------------------------------------------
  gru |  1.0000
  spz |  0.2083  1.0000
  bed |  0.0581  0.5123  1.0000
  pam | -0.2815 -0.3476 -0.0926  1.0000
alt65 |  0.2661  0.4899  0.5778  0.0606  1.0000
  vel | -0.1567  0.0700 -0.2265  0.1012 -0.2138  1.0000
  pop |  0.0470  0.6719  0.6190 -0.0433  0.4700  0.0111  1.0000
  alq | -0.0981  0.5947  0.2150 -0.0826  0.2092  0.1962  0.3259  1.0000
  fra | -0.2123  0.3988 -0.1059 -0.0240  0.1398  0.0820  0.0481  0.5591  1.0000
  mod |  0.1627  0.0092  0.3321  0.2138  0.1748 -0.0142  0.1313 -0.0726 -0.5756  1.0000
  trd |  0.0145  0.0325 -0.1326  0.4295  0.1921  0.1489  0.0040  0.3340 -0.0029  0.3400 1.0000
```

Model AZG chi2(11) = 32.74 Prob>chi2 = 0.0006	**Model AZS** chi2(11) = 7.31 Prob>chi2 = 0.7735
Model LHOS chi2(11) = 4.95 Prob>chi2 = 0.9337	**Model LAMB** chi2(11) = 32.74 Prob>chi2 = 0.0006
Model MED chi2(11) = -188.18 chi2<0 ==> model fitted on these data fails to meet the asymptotic assumptions of the Hausman test	**Model SOM** chi2(11) = 4.25 Prob>chi2 = 0.9622

5 Cost differences in Swiss nursing homes: a multilevel analysis

Abstract

Swiss nursing homes provide important services to the population and cost several billion Swiss francs every year. Statistical data show large annual per-bed cost differences between individual nursing homes and among cantons. The present article aims to empirically identify the factors explaining these sizable variations. The duality of potential explanatory factors at the individual nursing home and the cantonal levels is captured through multilevel regression modeling. The multilevel regression models explain a substantial part of the annual per-bed cost variation among values when grouped by cantons. However, a large part of the variation within the cantons remains unexplained, especially for the annual per-bed costs for accommodation and assistance.

5.1 Introduction

In 2006, the long-term inpatient care market in Switzerland included approximately 1,500 nursing homes, provided approximately 86,000 beds and costed an annual 6.8 billion Swiss francs (CHF). This volume corresponds to a share of 13 percent of the total Swiss healthcare expenditures in 2006, CHF 52.8 billion (FSO 2008a), and it underscores the economic importance of the sector. The average annual costs per available bed in Swiss nursing homes varied greatly both between individual facilities and cantons. The 2006 annual per-bed cost ranged from CHF 20,000 to CHF 162,000 per nursing home and from CHF 51,000 to CHF 123,000 per canton (see Figure 12 and Table 16).

There were extended speculations about the reasons for these large intra-cantonal and inter-cantonal differences in the Swiss media. The large variation in the occupancy rates of beds in different nursing homes and different cantons was assumed to be one of the main reasons. Other important factors that might explain the observed variations were the characteristics of the patients (case-mix) and the qualification levels of the nursing home staff: sicker patients and more qualified employees are expected to contribute to higher annual costs per available bed. Different nursing homes in Switzerland would also attract different clienteles by offering accommodation and assistance services at higher or lower standards.

Moreover, Swiss nursing homes are characterized by a strong federalist organization and regulation (Achtermann and Berset 2006; Camenzind 2008; Crivelli, Filippini, and Lunati 2002; Farsi, Filippini, and Lunati 2008; Filippini 1998). Differences in cantonal salaries and capital costs may also play a role. Another important factor is the possible existence of inefficiencies in the "production" of nursing home care. This point has been researched extensively in empirical Swiss studies (Crivelli et al. 2002; Farsi et al. 2008; Filippini 1998; Marti 2007); thus, it is not explored in this study.

The aim of this paper is to contribute to the evidence-based explanation that have been posited for the variations in the annual per-bed costs of Swiss nursing homes. In particular, the model explores whether it is possible to explain such differences with a set of indicators at the level of individual nursing homes and at the level of nursing homes grouped by canton. This question is approached by applying a particular statistical method and by using the Swiss federal statistics on socio-medical facilities (SOMED) as the central data source. The applied statistical method, multilevel modeling, enables the simultaneous quantitative determination of nursing home-oriented and cantonal factors that are linked with observed annual per-bed cost variations. To our knowledge, no Swiss studies have analyzed this issue using such a technique.

The paper is organized as follows: a brief overview of the academic literature on long-term care (i.e., supply, cost functions, and demand) is cited in Section 5.2; in Section 5.3, a statistical model is defined, and the available data are presented; in Section 5.4, the results found in the estimates for three different annual per-bed cost aggregates are shown; and these results are subjected to comment and conclusion in Section 5.5.

5.2 Background

The academic literature on the long-term care market cites three domains of providers (Grabowski 2008). The first important supplier is the informal home care provided in the context of unpaid work. The second domain is composed of professional or formal care services (including daily activities assistance) provided to the patient in his or her home (Weaver et al., 2008). This professional home care is called “Spitex” in Switzerland. The third domain of providers consists of nursing homes, as described in greater detail below. In addition to inpatient care services, many nursing homes provide transitional care, daycare services and assisted living.

Both nationally (FSO 2008a) and internationally (Christensen 2004), nursing homes can differ enormously in size. Researchers have intensively analyzed the most efficient size for nursing homes in terms of economies of scale. For Switzerland, one group of authors (Crivelli et al. 2002) argued that the most efficient size was 70 to 80 beds. Another group (Farsi et al. 2008) concluded that the most efficient size was 75 to 95 beds. Yet another Swiss author (Marti 2007) concluded that 130 to 180 beds was optimal.

Researchers have also investigated the effects of ownership arrangements and the entrepreneurial orientation of nursing homes on production processes and outcomes. To this end, a distinction can be made between public nursing homes, which are regulated in Switzerland by public administrative law and operate without exception on a non-profit basis, and private nursing homes, which are regulated by private company law *and* by public administrative law and operate both as for-profit and as non-profit facilities (see Appendix, Table 18). In Switzerland, 20 percent of the nursing homes are organized on a for-profit basis, and 80 percent are organized on a non-profit basis (FSO 2008b). In the United States, ownership arrangements seem to affect the characteristics of a nursing home's clientele (Spector, Selden, and Cohen 1998). In Switzerland, no differences between private and public nursing homes are found in terms of cost efficiency (Crivelli et al. 2002; Farsi et al. 2008).

Furthermore, the funding structure of nursing homes depends on ownership arrangements and legal regulations. In addition to payments per person, such as health insurance payments, social contributions and resident out-of-pocket payments, there are payments to non-profit nursing homes from public funds in the form of subsidies and payments to help cover deficits (Briesacher et al. 2009). A variable measuring the size of these subsidies was tested in the model presented in this paper. However, because this variable never showed a significant correlation with variations in cost, it was never actually included into the model.

In 2006, of the total costs of nursing homes in Switzerland of CHF 6.8 billion, CHF 1.4 billion (20 percent) was borne by mandatory health insurance (MHI). The costs of subsidies and payments to cover deficits for the cantons and communes were CHF 0.6 billion (9 percent). CHF 4.7 billion (69 percent) were privately funded by residents (FSO 2008c)—a share that seems very high by international standards (OECD/WHO 2006, 2011). One important reason for this high share is that it includes tax-financed supplementary benefits to Swiss old-age insurance (EL): CHF 1.7 billion of EL was provided to nursing home patients in 2006, and nursing home patients use a large portion of EL to finance the costs of accommodation and assistance. In the healthcare statistics reported by the Swiss Federal Statistical Office (FSO 2008a, 2008c), EL is categorized as "private healthcare expenditures." In contrast, most of the statistical systems of other Western countries treat similar funds as *social-related* and not as *health-related* expenditures, making such funds disappear from those countries' official health statistics.

The literature on healthcare economics has intensively explored ways to model *the functional form of the costs* generated by nursing homes. In general, the costs per nursing home bed depend on quantitative factors (e.g., nursing volumes), input prices (e.g., capital employed and wages), regulatory measures (e.g., payments to cover deficits or required staffing qualifications) and different technologies or production processes (e.g., the ratio of personnel expenses to production) (Lee and Birnbaum 1983). Some authors (Vitaliano and Toren 1994) explicitly incorporate ownership arrangements and entrepreneurial orientation into their cost functions, or they define a variable for the quality of the output provided (McKay 1988). Another author (Christensen 2004) takes account of the fact that nursing homes do not function independently from their environments. Although a nursing home does not have a direct effect on long-term costs, it can vary the inputs of the short-term cost function.

Three important studies were found that model specific cost functions for Swiss nursing homes. In the first study (Filippini 1998), the total nursing home costs were found to be a function of output (number of patient-days), prices for capital, labor and electricity, the average degree of physical dependence of the residents, the number of medical personnel employed compared to the number of personnel required by cantonal guidelines, the existence (or not) of apartments with limited support besides the main building (i.e., assisted living), and time trends.

The second study (Crivelli et al. 2002) included the following variables in the cost function: the number of patient-days, the prices for capital and labor, and the existence (or not) of apartments with limited support. The average degree of physical dependence in the older work of (Filippini 1998) was "replaced" by the average assistance time given to a nursing home's patient, which includes daily activities and medical care. Moreover, instead of using a relative number of medical personnel, a dummy variable expressing low or high average ratios of medical and nursing staff compared to patients was used. The list was complemented by three dummy variables that expressed the average ratios of expenditures of MHI to total expenditures, the (small or large) variety of services provided to patients, and the general individuality of cantons.

The third study from Switzerland (Farsi et al. 2008) proposed a cost function very similar to that defined in the study by Crivelli et al. (2002). The total costs of the nursing home in this work depended on the number of patient-days, the prices for capital and labor, the average assistance time given to a patient, and the average amount of MHI expenditures. Again, using dummy variables, the existence of apartments with limited support and low or high average ratios of medical and nursing staff to patients was used. Finally, a linear time trend was added. Compared to the cross-sectional approach by Crivelli et al. (2002), the main novelty of this study was its use of the panel econometrics approach.

The *demand* for long-term inpatient care is directly associated with the requirements for nursing care (Norton 2000). The worse the patient's state of health and the more the patient's daily ability to function independently is restricted, the greater the requirements for nursing care are. Because physical and mental complaints or restrictions occur more frequently with older age, the demand for long-term care is increasing in demographically aging societies (Spillman and Lubitz 2000). However, the greater demand for nursing care can also be triggered in younger generations by diseases or risk factors that are increasingly encountered, such as mental disorders or obesity (Höpflinger and Hugentobler 2005).

When choosing a service provider, patients and third-party funding bodies (e.g., health insurers, the state) prefer informal or professional home care for qualitative and monetary reasons. However, if the requirements for nursing care increase, a point will be reached at which (formal) home care becomes either too expensive or unfeasible (Borgetto 2003). At present, it is normally only at this point that those in need of nursing care are institutionalized in Switzerland (Jaccard-Ruedin et al. 2010).

Moreover, regional topographical differences must be considered in Switzerland. Admission to a nursing home can take place at an earlier stage for people who live in remote locations than for those living in an urban environment (Bayer-Oglesby, Höpflinger, and Camenzind 2007). Moreover, the policy of accommodation in regional acute care hospitals also influences the demand for beds in nursing homes. If hospitals are able or willing to keep chronically ill patients in acute, geriatric or rehabilitation wards, the regional demand for nursing homes is reduced. The opposite outcome occurs when there is great pressure to reduce the time spent in more expensive hospitals—for acute wards in particular.

For those with a potential demand for beds in nursing homes, such as those individuals in need of nursing care and their families, the distance between the residence and the nursing home location is a decisive factor in the choice of a particular facility (Norton 2000). Proximity to a nursing home usually stimulates regional demand. These decisions are closely associated with simultaneous considerations regarding a nursing home's quality (Grabowski 2008). This choice may, however, be restricted by regulatory authorities. Thus, admission is sometimes only possible by a hospital or must be approved by an admission authority. Such restrictions are necessary because, in Western countries, the demand for nursing home beds exceeds the supply in many markets (Crivelli et al. 2002; Grabowski 2008; Norton 2000). In

Switzerland, this excess demand has partly been caused by moratorium on building new nursing homes in certain cantons during certain periods of time (e.g., between 1992 and 2000 in the canton of Geneva).

5.3 Methods and materials

5.3.1 Methodological approach

The central data source used in this work, SOMED statistics on nursing homes (see Section 5.3.2), is the result of an extensive revision with a new series of data starting in 2006. On the one hand, this revision made direct comparisons with older data difficult, and, for several indicators, the FSO experts advised against making such comparisons. On the other hand, no data more recent than 2006 were available for the research project at the time of its conception. Hence, it was decided to work in this study with only one single year (2006) of SOMED data and to gain experience by working with a cross-level setting and its limitations[72].

Clear evidence shows that the average annual per-bed costs of Swiss nursing homes do not only depend on demand and supply factors on the level of the individual institution, but also on structural factors on the regional or cantonal level. Thus, to explain the variations of annual per-bed nursing home costs in Switzerland, it seemed reasonable to utilize statistical models that are able to incorporate data at varying hierarchical levels. Such multilevel models are advantageous because data do not need to be aggregated; thus, information is not lost on lower levels (Christensen 2004; Hox 2002).

Normally, multilevel regression analyses focus on models in which the dependent variable is measured at the lowest hierarchical level (DiPrete and Forristal 1994). For this work, the variation of three cost items (designated hereinafter as C_{ij}) was investigated at the level of 1,186 facilities (i = 1, 2, …, 1,186) located in 25 cantons (j = 1, 2, …, 25) (see Table 16). All three cost items are considered to be linear and normally distributed (see Appendix, Figure

[72] Compared to panel data analysis, the cross-sectional approach that this article uses has several disadvantages: among others, cross-level models cannot consider unobserved heterogeneity in the model. Neglecting such individual effects often produces biased estimates. And, in general, because (time-)dynamic processes cannot be modeled, causal interpretations of two simultaneous events are excluded.

13). $\mathbf{X}_{ij}$ is a vector of variables at the nursing home level. In algebraic notation (Hox 2002), the following model results:

$$C_{ij} = \beta_{0j} + \beta_{1j}\,\mathbf{X}_{ij} + e_{ij}, \quad \text{where } e_{ij} \sim N\,(0, \sigma_e^2) \tag{1}$$

In this regression model, each of the 25 cantons J has an individual coefficient for axis intercept β_{0j} and an individual coefficient for slope β_{1j}; index j expresses this in Equation (1). Across all cantons J, these coefficients have their own mean values, variances and error terms, and they are dependent on a set of Q variables Z_{qj} that vary across the cantons. In a simplified notation with only one variable Z_j at the cantonal level, this can be expressed as follows:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,Z_j + u_{0j}, \quad \text{where } u_{0j} \sim N\,(0, \sigma_{u0}^2) \tag{2a}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}\,Z_j + u_{1j}, \quad \text{where } u_{1j} \sim N\,(0, \sigma_{u1}^2) \tag{2b}$$

In Equation (2a), the *level* of annual average costs per nursing home bed in canton J—axis intercept β_{0j} of Equation (1)—depends on the canton-specific variable Z_j. The strength and direction of the correlation between the annual costs per nursing home bed in the same canton J—slope β_{1j} in Equation (1)—depends on Z_j as well. The regression coefficients γ_{00}, γ_{01}, γ_{10} and γ_{11} do not vary across cantons (i.e., they are fixed regression coefficients). If equations (1), (2a) and (2b) are combined and a number P of explanatory variables X_p at the level of nursing homes and of Q explanatory variables Z_q at the grouped level of cantons are taken into consideration, then the following two-level regression models can be defined (Braun et al. 2010; Snijders and Bosker 1994):

$$C_{ij} = \gamma_{00} + \gamma_{p0}\,\mathbf{X}_{pij} + \gamma_{0q}\,\mathbf{Z}_{qj} + u_{0j} + e_{ij} \tag{3a}$$

$$C_{ij} = \gamma_{00} + \gamma_{p0}\,\mathbf{X}_{pij} + \gamma_{0q}\,\mathbf{Z}_{qj} + u_{pj}\,\mathbf{X}_{pij} + u_{0j} + e_{ij} \tag{3b}$$

$$C_{ij} = \gamma_{00} + \gamma_{p0}\,\mathbf{X}_{pij} + \gamma_{0q}\,\mathbf{Z}_{qj} + \gamma_{pq}\,\mathbf{X}_{pij}\,\mathbf{Z}_{qj} + u_{pj}\,\mathbf{X}_{pij} + u_{0j} + e_{ij} \tag{3c}$$

Equation (3a) describes a *random intercept model* containing variables at the individual and group levels. Equation (3b) adds the random slope term $u_{pj}\,\mathbf{X}_{pij}$ to model (3a) and is called the *random slope model*, containing variables both at the individual and group levels. If the term $\gamma_{pq}\,\mathbf{X}_{pij}\,\mathbf{Z}_{qj}$ is added in Equation (3c), it is possible to introduce *cross-level effects* into the (random slope) model. The last of these can model a possible interaction of the variables between the first level of nursing homes I (vector $\mathbf{X}_{pij}$) and the second level of cantons J (vector $\mathbf{Z}_{qj}$). The term [u_{pj} $\mathbf{X}_{pij}$] in Equations (3b) and (3c) shows that, in random slope models, the vectors $\mathbf{X}_{pij}$ are not independent of error terms u_{pj}, and the total error in the estimations is dependent on the magnitude of the values for the vectors $\mathbf{X}_{pij}$. This results in heteroscedasticity, which is why the application of ordinary least squares (OLS) estimators is eschewed in favor of using maximum likelihood (MLE) estimators in random slope multilevel models (Bryan 2008; Hox 2002). For random intercept models (3a), a generalized least squares (GLS) estimator with its practical calculations of within- and between-group variances is still feasible (see Section 5.4.1).

For the multilevel regression estimates in this work, the STATA11® software was run with "xtreg" and "xtmixed" orders to execute GLS *and* restricted maximum likelihood regressions (REML) for the random intercept models (3a); only REML was used for the random slope models (3b). The Likelihood-Ratio-Test (LRT)[73] (Rabe-Hesketh and Skrondal 2005) was used to check whether the randomization of the group slopes brought a statistical gain to the models. Furthermore, the independent variables were centered on their overall (grand) means in the calculations (see annex _C in the STATA outputs in the Appendix, Table 19).

Then, cross-level effects in random slope models (3c) could be calculated simply by creating linear combinations (i.e., multiplying) of two variables at two different levels and applying REML afterwards (Braun et al. 2010). However, as will be shown in the Results Section (5.4) of the article, randomization of the group slopes brought only a small statistical gain (in two models) or even a tendency toward decreasing quality (in one model). Accordingly, such interactions were not examined further in the model; thus, the step described in Formula (3c) was not executed in the study.

5.3.2 Data

Cost indicators

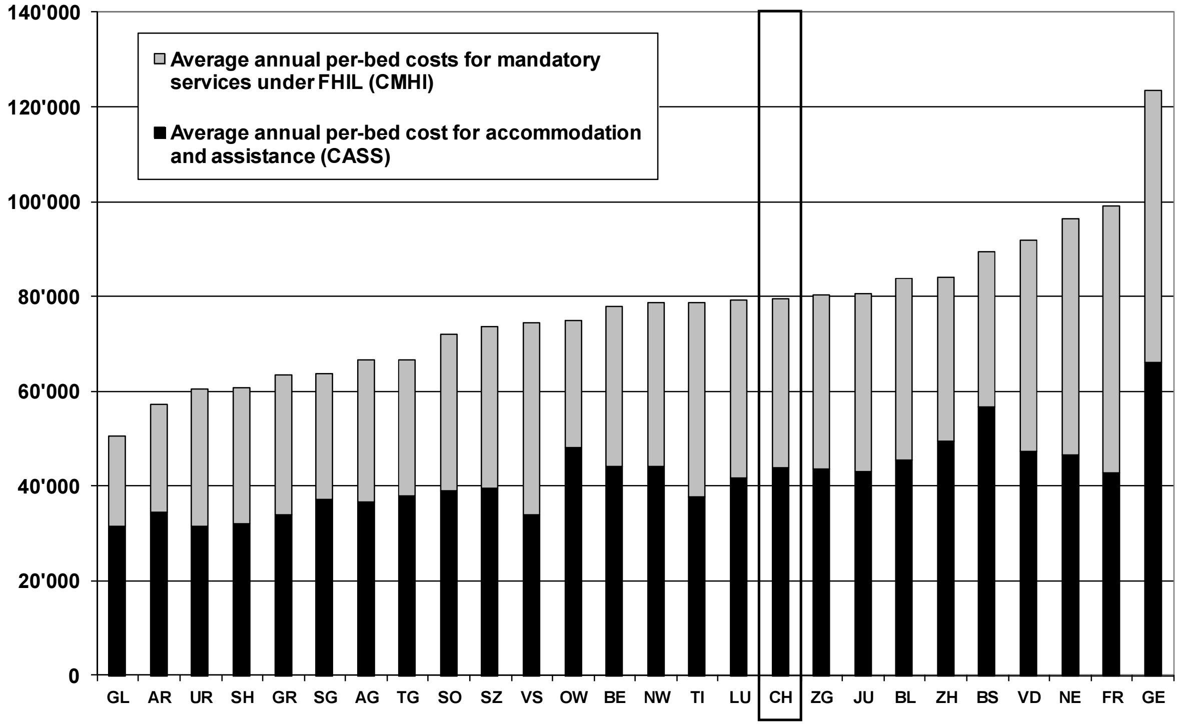
The central data source for empirical analyses on nursing homes in Switzerland is SOMED, which is compiled by the Swiss Federal Statistical Office (FSO 2008a, 2008b). SOMED also contains information on homes for the elderly, facilities for the disabled, and facilities for

[73] The Likelihood-Ratio-Test (LRT) compares the (REML-)estimated *random intercept model* results with the (REML-)estimated *random slope model* results by performing a statistcal test to show whether the randomization of a level 2 variable (WAG) results in a statistically significant improvement in model fit.

people with addiction or psycho-social problems. All of this information is excluded, with only SOMED data on *nursing homes* being used. In the SOMED data on nursing homes, two main cost items were distinguished: "costs for accommodation and assistance" and "costs for mandatory nursing and medical services under the Federal Health Insurance Law" (FHIL, i.e., services covered by MHI).

According to Figure 12, the total average annual per-bed nursing home costs (C^{TOT}) were CHF 80,000 in Switzerland (CH) in 2006. These costs consist of "annual per bed costs of accommodation and assistance" (C^{ASS}) of CHF 44,000 and "annual per bed costs of mandatory services under FHIL" (C^{MHI}) of CHF 36,000. These costs in the dataset reflect both public and private nursing homes and consist of wages, employee benefits and material costs. The last are the expenses to maintain the daily activities of the nursing home and also include the interest on capital. However, other capital costs (i.e., depreciation) are not included.

Figure 12: Annual per-bed costs in nursing homes, by type of cost and canton, 2006, in CHF



Source: SOMED (FSO 2008a); calculations by the author.

Using a regional (i.e., cantonal) comparison, C^{TOT} varies from CHF 51,000, on average, in the least expensive canton (Glarus, GL) to CHF 123,000 in the most expensive canton (Geneva, GE). The same cantons, GL and GE, show the minimum and maximum values for the two cost components: CHF 31,000 and CHF 66,000 for C^{ASS} and CHF 19,000 and CHF 57,000 for C^{MHI}.

Determinants of nursing home costs

Supported by the cited Swiss literature (Crivelli et al. 2002; Farsi et al. 2008; Filippini 1998)[74], the following function determining all three annual per-bed cost items (i.e., C^{TOT}, C^{ASS}, and C^{MHI}) is proposed. To simplify matters, all three of them are designated as "C" in Equation (4):

$$C = f\,(DAY, INT, SIZ, SIQ, QUP, AUX, REG, WAG, RNT, BED) \qquad (4)$$

In accordance with proposed total cost functions of the Swiss authors, the annual per-bed cost function for nursing homes in Equation (4) contains an output variable: the number of patient-days invoiced per nursing home bed (DAY, i.e., the occupancy rate of the nursing homes). As a proxy for the average case mix of the patients, the variable INT is introduced to the model (i.e., the average time per patient day spent for nursing under FHIL; the minutes measured were recorded to integers varying between 1 and 13). INT was calculated by the FSO for the first time in 2006 (FSO 2008b), and it should be interpreted with caution. There are different cantonal requirements-for-care assessment systems, and INT can either be an ex-post account for concrete services delivered or an ex-ante classification of requirements-for-care time.

Similar to what was reported in the aforementioned Swiss articles, in this study, the size of the nursing home, measured by the number of available beds (SIZ), was tested as a proxy indicator of the service provision structure. Larger nursing homes are usually able to offer a

[74] The cited literature actually considers the estimations of a stochastic translog frontier cost function that is based on economic production theory (i.e., with properties such as a cost function that is concave and linearly homogeneous in input prices and non-decreasing in input prices and output; the functional form of such a cost function is specified as a translog cost function).
The approach of our model is much simpler and makes use of just one element of the models proposed in the above-mentioned econometric literature: the variables (output level, relative input prices, etc.) used in the long-run cost functions that represent a nursing home's total operational cost. Our simple model can be called a "*hedonic cost function model*."

greater numbers of different and more specialized services to their clientele than smaller nursing homes (Crivelli et al. 2002). Moreover, the economies of scale posit a negative link between the size of nursing homes (SIZ) and per-bed costs, at least until the optimal size of the nursing home is reached. For even larger nursing homes, per-bed costs are expected to rise again. This type of U-form cost curve is modeled by adding the square of the size variable (SIQ) to the equation.

The ratio of qualified personnel (QUP; i.e., the number of medical doctors and qualified nursing personnel per 100 available beds) is introduced. QUP serves as an indicator of the nursing home's level-of-care quality. However, QUP might be also a proxy variable for the average case mix of a nursing home's patients[75]. Moreover, a variable for the hospitality standard of the nursing homes must be identified. The ratio of patient-days spent to the number of non-medical personnel is calculated (variable AUX) for this purpose.

As a cultural indicator of the location of nursing homes, the dummy variable REG (i.e., identifying the official language as being German or not) is introduced. Unlike the other Swiss authors, who use cantonal dummies, the indicator REG is used at the nursing home level. Several Swiss cantons, such as Fribourg (FR), Valais (VS), Berne (BE), and Graubünden (GR), have German *and* one of the three other official Latin languages (French, Italian, or Romansh) inside their territory. In canton FR, for example, 28 nursing homes indicate French and eight nursing homes indicate German as the official language; variable REG takes this into account. SOMED is the underlying data source for all seven indicators at the nursing home level in Equation (4) (see Appendix, Table 18).

With regard to the correlational hypotheses, theoretical and literature-supported positive links are expected for the first four indicators. A higher occupation (rate) of available beds (DAY) should lead to higher annual per-bed costs. The same is true for INT: more time spent per patient on average means more per-bed costs. The economies of scale anticipate a negative link between the size of the nursing homes (SIZ) and per-bed costs, at least until the optimal size of the nursing home is reached. For even larger nursing homes, per-bed costs are expected to increase again, and this is taken in consideration by introducing the square of the size variable (SIQ) to the equation. For the indicator QUP, a positive relationship with per-bed costs is expected, because a highly qualified medical staff represents the best-paid

[75] The variables QUP and BED are poorly correlated with one another (see Appendix, Table 20).

personnel group in a given nursing home. A negative link is expected for the indicator AUX: the more days that are provided by non-medical employees are invoiced per nursing home bed, the lower the hospitality standard should be. Finally, it is not possible to derive clear assumptions from the national literature for the correlation between REG and annual per-bed costs. Public discourse in Switzerland rather assumes a positive link between per-bed costs and nursing homes in Latin-speaking areas.

The other three variables in Equation (4) are at the cantonal level and pertain to the average monthly gross wages in the healthcare sector (WAG), the average rental fee indices (RNT), and the density of nursing home beds (BED). In accordance with the Swiss studies mentioned above, WAG and RNT represent the cantonal factor prices in the model. The cantonal density of nursing home beds (BED) is introduced as a proxy variable for the supply structure in the cantonal long-term care markets. BED is a new variable compared to the other Swiss models mentioned above. It is defined as the number of nursing home beds in the canton in relation to the population of (1,000) individuals who are 65 years and older. The three indicators at the cantonal level, WAG, RNT, and BED[76], are based on the following data sources provided by the FSO: "Swiss labor census," "National index of consumer prices," and "SOMED and population statistics" (see Appendix, Table 18).

Based on theory and the literature, one would expect WAG and RNT to positively correlate with annual per-bed nursing home costs. Correlations with a better-developed cantonal supply of nursing home beds (BED)[77] are less clear. Theoretically, a greater availability of nursing home beds should relieve the demand and prices of such beds. At the same time, in a functioning market, one would expect a reduction in the average annual per-bed costs. However, no such effect can be expected if the actual demand in cantonal nursing home markets exceeds supply, as is the case in many Western countries (Crivelli et al. 2002; Grabowski 2008; Norton 2000). Thus, in reality, a smaller supply of beds in a Swiss canton

[76] These 3 independent variables introduce risks of provoking ecological inference fallacies. These are logical fallacies in the interpretation of statistical data where inferences about the nature of individuals (i.e., individual nursing homes) are deduced from inferences for the groups (i.e., cantons) to which those individuals belong (see Kramer, G. H. 1983. "The Ecological Fallacy Revisited: Aggregate- versus Individual-level Findings on Economics and Elections, and Sociotropic Voting." *The American Political Science Review* 77(1): 92-111.).

[77] Aside from the problem of ecolocical fallacy, endogeneity problems must be suspected for the variable BED for reasons including omitted variables and variable selection bias.

might merely result in—on average—sicker patients occupying these fewer available beds in the cantonal nursing homes.

Data cleaning

Of the 1,490 nursing homes that were active in 2006, statistical information is available on 1,463 facilities because 27 nursing homes did not supply details to the FSO that year. This dataset was cleaned with the objective of eliminating facilities with missing or implausible values for the variables of relevance (see Appendix, Table 18). This cleaning procedure resulted in 1,186 nursing homes; 304 facilities were excluded because of missing or defective data, indicating a loss of 15 percent with respect to the total number of beds offered. The 1,186 remaining nursing homes were divided among 25 location cantons, with a minimum of 5, a maximum of 199 and an average of 47 facilities per canton. No nursing homes were located in the canton of Appenzell Innerrhoden (AI). For the interpretation of the regression results, it should be noted that small cluster sizes create no (or only limited) problems when testing *fixed regression coefficient models* (Snijders 2005).

5.4 Results

5.4.1 Overview

The descriptive statistics in Table 16 show the number of observations (OBS), mean values (MEAN), standard deviations (STD.DEV.), minimal values (MIN) and maximal values (MAX) of the variables. The national means of per-bed cost variables C^{TOT}, C^{ASS}, and C^{MHI} in 2006 were CHF 79,000, 44,000, and 36,000, respectively (see Figure 12). The MIN and MAX per individual nursing home ranged from CHF 21,000 to 162,000 for C^{TOT}, from CHF 6,000 to 108,000 for C^{ASS}, and from CHF 2,000 to 97,000 for C^{MHI}. Moreover, the three dependent variables C^{TOT}, C^{ASS}, and C^{MHI} are all continuous, approximately normally distributed[78] (see Appendix, Figure 13), and do not contain any outliers; thus, the use of a parametric linear model seems appropriate.

[78] To obtain a better fit to the normality assumption of the dependent variable, the natural logarithms of HOS (i.e., LHOS) and AMB (i.e., LAMB) were used in the regression equations.

The variable DAY shows that Swiss nursing home beds were occupied 346 days a year on average. The MAX of 401 days demonstrates that it was possible to invoice more than 365 days for one bed. INT shows the recoded average time level indicator ranging from 1 to 13 entities; its mean value was six entities, indicating an average nursing time per patient per day of 101 to 120 minutes. The size of the nursing homes measured via the number of available beds (SIZ) varied between six beds and 318 beds in 2006; the mean value for the entire country was 61 beds. SIQ is the variable containing the squares of SIZ and is not further discussed here.

Table 16: Descriptive statistics

Variable	OBS	MEAN	STD.DEV.	MIN	MAX
CTOT	1186	79397	21566	20978	162286
CASS	1186	43880	13325	5860	108192
CMHI	1186	35518	14415	2375	96578
DAY	1186	345.8	25.6	202.9	400.8
INT	1186	5.871	2.118	1	13
SIZ	1186	61.1	41.8	6	318
SIQ	1186	5479.1	9099.8	36	101124
QUP	1186	29.64	13.67	0.6	88.1
AUX	1186	737.1	236.0	154.7	1652.9
REG	1186	0.278	0.448	0	1
WAG	25	5688.3	214.8	5402	6137
RNT	25	1093.0	123.5	810	1480
BED	25	72.7	12.0	49.6	96.7

Sources: See Appendix, Table 18.

The variable QUP indicates that approximately one-third (MEAN = 0.30) of personnel were qualified medical personnel. The variation in QUP between nursing homes was large (from 0.6 to 88.1). The variable AUX shows that the average Swiss nursing home invoiced 737 patient-days per non-medical employee. The variation for AUX is large as well and ranged from 155 days to 1,653 days. The average monthly gross wage level in health care (WAG) was CHF 5,700 and varied from CHF 5,400 to CHF 6,100 between cantons. The 2003 private home rent index averaged 1,093 points and varied between 810 points (-25.9 percent under the national average) and 1,480 points (+35.4 percent above the national average). Finally, the average supply of nursing home beds compared to the population aged 65 years and older (BED) was 73 beds per 1,000 persons. The cantonal variation was important for BED as well and ranged from 50 up to 97 beds.

Table 17: Regression estimates (random intercept model, GLS estimator) on cost variations in Swiss nursing homes, 2006

	C^{TOT}	C^{ASS}	C^{MHI}
CONS	79,457***	43,595***	35,956***
DAY	112.3***	60.2***	54.9***
INT	2,807.2***	355.2 (n.s.)	2431.1***
SIZ	0.29 (n.s.)	-41.3**	37.2**
SIQ	0.07 (n.s.)	0.12 (n.s.)	-0.03 (n.s.)
QUP	581.6***	201.4***	380.4***
AUX	-22.7***	-13.3***	-9.7***
REG	2,898.7 (n.s.)	1,157.6 (n.s.)	3,739.9***
WAG	27.4**	18.4**	8.3*
RNT	9.4 (n.s.)	10.7 (n.s.)	0.88 (n.s.)
BED	-169.7 (n.s.)	-86.6 (n.s.)	-49.2 (n.s.)
R^2_{within}	53.9 %	14.8 %	48.3 %
$R^2_{between}$	75.5 %	48.6 %	87.5 %
$R^2_{overall}$	61.5 %	25.6 %	61.5 %

*** *Positive or negative* correlation significant at the 99 percent level or higher;
** *Positive* or *negative* correlation significant at the 95 percent to 99 percent level;
* *Positive* or *negative* correlation significant at the 90 percent to 95 percent level;
(n.s.) *Not significant* (positive *or* negative) correlations at the 90 percent level or lower.

Table 17 shows the results for the random intercept model calculated with GLS estimators (see also Appendix, Table 19, with a comparison of GLS and REML estimator results). Therefore, the regression coefficients and constants (CONS), with their significance levels *and* their proportions of the explained variance, can be shown for each cost variable. These variances include the *within* variance (R^2_{within}; i.e., the explained share of variance between the individual nursing homes within every canton), the *between* variance ($R^2_{between}$; i.e., the explained share of the variance of cantonal means with respect to the national mean), and the *overall* variance ($R^2_{overall}$; i.e., the explained share of the sum of the within and the between variances).

For C^{TOT} and C^{MHI}, the models' overall explanatory contributions ($R^2_{overall}$) are quite high, at 61.5 percent for both cost indicators; however, with C^{ASS}, it is only 25.6 percent, primarily due to a small contribution of the explained variation of the values within the cantons (R^2_{within}, 14.8 percent) in the regression equation to C^{ASS}. With C^{TOT} and C^{MHI}, the R^2_{within} is 53.9 percent and 48.3 percent, respectively. With all three cost items, the explained variations between the values grouped by cantons ($R^2_{between}$) are high. The explained variations are 75.5 percent for C^{TOT}, 48.6 percent for C^{ASS}, and 87.5 percent for C^{MHI}. Particularly with C^{ASS}, but also with C^{TOT} and C^{MHI}, the model can clearly explain more variation *between* the values grouped by cantons than between the individual nursing home values *within* the 25 cantons. The Wald test is performed to review the individual and combined linearities of the estimated parameters, and it shows high values in all three estimating equations, confirming the accuracy of the linearity assumptions.

5.4.2 Variations in the total costs (C^{TOT})

With regard to the C^{TOT}, positive correlations with the four independent variables (and CONS)—occupancy rate (DAY), average case mix of the patients (INT), personnel quality (QUP), and monthly gross wages in the healthcare sector (WAG)—are observed. The positive link between a higher C^{TOT} and a greater number of days of residence invoiced per nursing home bed (DAY) is in line with expectations. Concretely, one more patient-day per bed and year coincides with a supplementary C^{TOT} of CHF 112. The same is true for INT, for which one level point (i.e., 20 minutes) more of nursing time needed per patient day means CHF 2,807 more total annual costs on average. One more person of qualified personnel per 100 nursing home beds reflects supplementary C^{TOT} of CHF 582. Additionally, one index point of the higher monthly gross wage level (WAG) corresponds to an average of CHF 27 greater annual per-bed costs[79]. Furthermore, the expected negative correlation between AUX and C^{TOT} is confirmed. One more patient-day invoiced in relation to non-medical personnel reduces the annual per-bed total costs by CHF 23. The coefficients for DAY, INT, QUP, and AUX (including the constant term) are statistically significant at the 99 percent level, and WAG is significant at the 95 percent level; all other variables (SIZ, SIQ, REG, RNT, and BED) show insignificant coefficients.

Estimating C^{TOT} with the STATA11® "xtmixed" order to execute a REML estimation (instead of a "xtreg" order to execute a GLS estimation) generates almost identical results (see Appendix, Table 19). Moreover, a random slope model (the slope of group-significant variable WAG is randomized for this purpose) again produces very similar results to those of both variants of the random intercept approach (see Appendix, Table 19). The only gain is the estimation of a somewhat larger influence (viz., a coefficient of CHF 61 instead of CHF 28) and an increased significance of the coefficient of WAG (from 95 to 99 percent). The LRT also indicates that the use of a random slope model for C^{TOT} could be a good choice.

5.4.3 Variations in the costs of accommodation and assistance (C^{ASS})

For the second cost item investigated (i.e., C^{ASS}), four variables at the nursing home level and one variable at the cantonal level (and the constant term CONS) are significantly correlated (see Table 17). At the nursing home level, the same three variables are involved as in the case of C^{TOT}: namely, those for occupancy rate (DAY), quality of personnel (QUP), and hospitality standard (AUX). However, unlike with C^{TOT}, it is not INT but SIZ that significantly regresses onto C^{ASS}. Interestingly, SIZ is negatively related to C^{ASS} and can be interpreted as follows: if the size of a nursing home is increased by one bed—at the average size of Swiss nursing homes of 61 beds—than the average costs for accommodation and assistance of this home are expected to be CHF 41 lower. The links of DAY, QUP, and AUX with C^{ASS} are again evident. For the negative correlation of AUX and C^{ASS}, a *stronger* link was actually expected. One additional invoiced day in relation to the number of non-qualified medical personnel (AUX) reduces the per-bed costs by only CHF 13 on average.

[79] This result is certainly "polluted" by an ecological fallacy.

The three variables at the cantonal level, WAG, RNT, and BED, show the expected links with C^{ASS}, but only the coefficient for WAG is statistically significant. Calculating the regression to C^{ASS} with a REML estimator again produces almost identical results to the GLS estimator (see Appendix, Table 19). Moreover, calculation of C^{ASS} was attempted using a random slope model. All three group variables—WAG, RNT, and BED—were tested for this purpose. Unfortunately, the software could not estimate such a model[80], and no results can be given.

5.4.4 Variations in the mandatory costs of nursing under FHIL (C^{MHI})

For the variation in C^{MHI}, Table 17 shows significant correlations with six variables at the nursing home level and with one variable at the cantonal level (in addition to the constant term CONS). Four of the six indicators at the nursing home level, DAY, INT, QUP, and AUX, show the expected links. The other two significant variables, SIZ and REG, require some additional comment. In contrast to the case of C^{ASS}, SIZ is *positively* related to C^{MHI}: for Swiss nursing homes of 61 beds (the average size for the country), a nursing home that is larger by one bed averages CHF 37 higher annual costs per bed for nursing under FHIL. The variable REG (i.e., the official language being German or not) that had been introduced as cultural indicator of the location of a nursing home shows a significant positive coefficient in the regression for C^{MHI}. If the nursing home is located in a Latin-speaking environment, the expenses for MHI services are, on average, CHF 3,740 higher than in a German-speaking environment. Finally, in the regression results of the three variables at the cantonal level for C^{MHI}, the variable WAG shows a positive and significant coefficient at the 90 percent level. The other two canton-level variables, RNT and BED, indicate *insignificant* coefficients, as occurred in the other two equations for C^{TOT} and for C^{ASS}.

In the regression for C^{MHI} calculated with a REML estimator, results almost identical to those calculated using a GLS estimator are obtained (see Appendix, Table 19); however, the coefficient for WAG becomes insignificant. Moreover, for C^{MHI}, a random slope model was calculated (see Appendix, Table 19). Again, the slope of the group variable WAG was randomized. The results obtained were quite similar to the results of both variants of the random intercept model. The coefficient of WAG surpasses a significance level of 99 percent

80 Either the standard error calculations or preformance of the gradient-based optimization in the REML routine failed.

in the random intercept model. The LRT produces a rather small chi^2-value at the limits of significance (a probability of 6 percent); hence, the quality of the model is not really increased.

5.5 Discussion

This study explicitly takes into account the heterogeneity of the federalist structure of the Swiss healthcare system in the specification of a statistical estimation model. When applying such a multilevel technique, it is demonstrated that characteristics on *both levels* (cantons and individual nursing homes) can be significantly correlated with the variation in different per-bed cost indicators. Moreover, this model can reflect the shares of cost variations attributed to the ten variables that are introduced for the two levels in the model.

The model is able to explain a substantial part (between 49 percent and 88 percent) of the variation *between* the grouped cost values (i.e., between cantons). However, the model is less useful for explaining the large per-bed cost variations *within* cantons—in particular, for C^{ASS}. The unexplained intra-cantonal parts of C^{MHI} are less important in the model, which is in line with expectations, because the benefits chargeable to FHIL are clearly defined in the national MHI benefit basket, and they should have a homogenizing effect on C^{MHI}. In contrast, C^{ASS} is primarily financed by out-of-pocket payments and is not subject to such regulations.

The model attempts to capture different *hospitality standards* among the individual institutions using the variable AUX. The extent of the correlation between AUX and the three cost items—in particular, for C^{ASS}—proves to be less important than expected. A better variable than AUX might be found outside the SOMED; for example, an indicator for the average per capita surface of patient rooms, most likely available in the annual reports of the individual nursing homes, would fit this need. Moreover, a cross-sectional multilevel model is certainly not the best choice to explain the heterogeneity in terms of costs of nursing homes operating in a given canton. A *fixed-effect panel data model* would have better controlled for such unobserved heterogeneity. The years after 2006 in SOMED should now be accessible for such an analysis.

Other limitations of the results are associated with the limitations of the data. With regard to the quality of the data, SOMED is a comprehensive survey and is not subject to distortions. However, 2006 was the first year of data collection after the statistics were revised, and a revision is always associated with certain coding changes and other uncertainties. Moreover, 15 percent of the nursing homes needed to be removed because of missing or defective data. The potential bias that results from this selection method is inevitable.

Because of data limitations, no analyses were conducted at regional levels smaller than the canton. Because Swiss cantons vary enormously in size, the formation of sub-cantonal regions with greater homogeneity could have brought additional stability to the model, as would a greater number of observations. Moreover, expanding the model in the direction of individual nursing home clients could have been interesting. Because SOMED was revised in 2006, data are available at the individual level. Unfortunately, SOMED does not include any details on the costs to these individual residents. Such an expansion has been suggested by an investigation on treatment in Swiss acute care hospitals, where a substantial part of the cost variation is accrued at the patient level (Matter, Widmer, and Busato 2009).

In conclusion, it is considered whether some of the results in this study can be used to make recommendations for the authorities in cantonal or federal government entities. With respect to the future increased demand for nursing home beds, attention is focused on cost-containment strategies for cantons.

Concerning the seven indicators analyzed at the nursing home level, large occupancy of beds (DAY) and highly qualified personnel (QUP) are identified to be important “drivers” for all three cost items. Faced with the problem of a demand that exceeds the supply (Crivelli et al. 2002; Grabowski 2008; Norton 2000), such expensive, intensively used, and highly quality-staffed nursing home beds should be in the interest of government authorities (Lyons et al. 2008; Zuniga et al. 2010), even in the case of cantons with an explicit cost-containment mandate for nursing home care. For C^{MHI} in particular, more nursing time employed per patient (INT) and location in a Latin-speaking region (REG) are other significantly correlated factors on the individual level. A higher intensity of nursing is more costly for MHI, and—given identical medical practices of nursing services and their coding in Latin- and German-speaking regions—patients in nursing homes in the Latin-speaking regions[81] of Switzerland show larger case loads on average.

Moreover, the estimation models show significant coefficients for the number of non-medical employees (AUX) in the equations for all three cost items. Unfortunately, only a small part of the varying intra-cantonal “hospitality standards” captured by this indicator could be explained by the models. It seems rather difficult to derive recommendations for policy makers from this result. Furthermore, the motivation of cantonal authorities to intervene in “intra-cantonal sub-markets for accommodation and assistance” is limited, excepting that large deficits in nursing home budgets would demand an increase of cantonal subsidies. Therefore, it is still recommended that cantonal authorities continuously *monitor* these costs of accommodation and assistance in the nursing homes of their cantons. If an increasing number of people among those with chronic illnesses and daily limitations (OECD/WHO 2011) are unable to pay these costs out of their own budgets, then market interventions by the cantons could become necessary.

The influence of healthcare policy is also very limited with respect to the three variables that were modeled at the cantonal level: WAG, RNT, and BED. If—with a cost containment focus—wage levels in the (public) healthcare sector were to be reduced, public nursing homes would be at risk of losing some of their staff to private nursing homes, to other economic sectors or to better paying cantons. Finally, the two indicators for the cost of private housing (RNT) and for the density of nursing home beds (BED) in the cantons never showed significant coefficients in the calculations. Hence, they are unlikely to be useful for policy recommendations. In summary, it can be said that further research—using panel data indicators and methodologies, searching for better indicators of hospitality standards of the nursing homes, and attempting to model the different cantonal regulations at the second level—is highly recommended.

[81] Latin-speaking regions in Switzerland show higher population densities on average than German-speaking regions. Hence, it is highly probable that the variable REG (introduced as a ”cultural location factor”) is partly a proxy for the remoteness of a region with a larger share of (less intense) inpatient care in the total long-term care milieu.

Appendix, Chapter 5

- **List of abbreviations used (see Table 18 for the acronyms of the tested variables)**

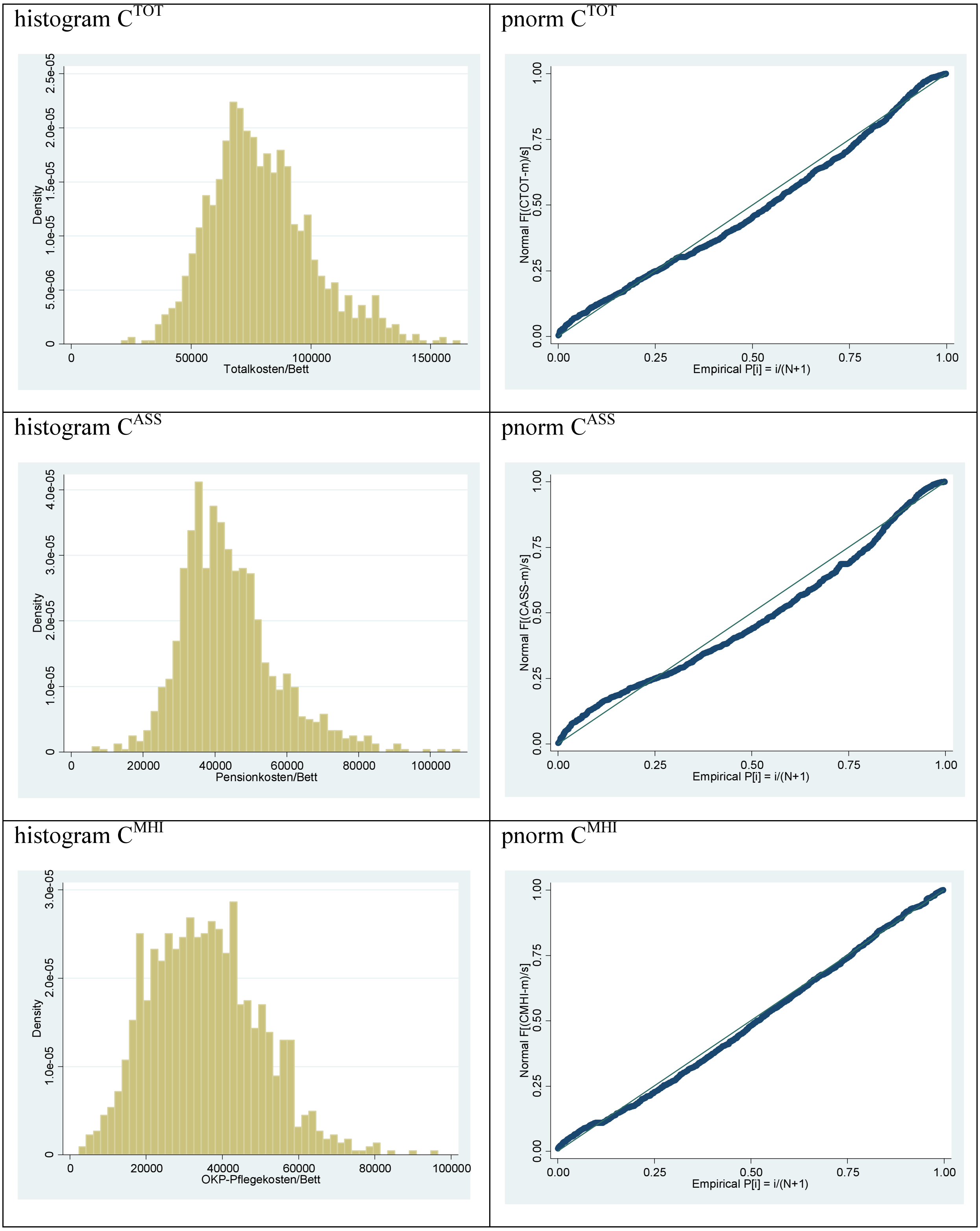
FHIL: Federal Health Insurance Law; CHF: Swiss francs; FSO: Swiss Federal Statistical Office; SOMED: Swiss federal statistics on socio-medical facilities; MHI: Mandatory health insurance; OECD: Organization of Economic Co-Operation and Development; WHO: World Health Organization; EL: Supplementary benefits to the old age and the invalidity insurance; CONS: Constant term; OBS: Observations; MEAN: Mean value; STD.DEV.: Standard deviation; MIN: Minimum value; MAX: Maximum value; OLS: Ordinary least squares (regression); GLS: Generalized leased squares (regression); MLE: Maximum likelihood (regression) estimator; REML: Restricted maximum likelihood (regression) estimator; LRT: Likelihood-ratio-test.

- **Additional Tables**

Table 18: Description of variables

Variable	Variable label	Meaning/description of indicator	Data source	Formula/indicator see (FSO 2008b)
KTNR	Canton	Sequential number of the Swiss cantons (without Appenzell Innerrhoden AI)	FSO 2008a	KTNR = 1, 2, …, 25
C^{TOT}	Per bed total costs	Annual per-bed total costs in CHF; OBSs under CHF 20,000 and over CHF 170,000 excluded as "outliers"	SOMED 2006	E1.300.01 / B03
C^{ASS}	Per-bed costs of accommodation and assistance	Annual per-bed costs in CHF for accommodation and assistance	SOMED 2006	(E1.300.02 + E1.300.03) / B03
C^{MHI}	Per-bed costs of MHI care services	Annual per-bed costs in CHF for mandatory services under FHIL	SOMED 2006	(E1.300.04 + E1.300.05 + E1.300.06 + E1.300.07 + E1.300.08) / B03
DAY	Patient-days per available bed	*Output*: number of annual patient-days accounted per available bed; OBS under 183 days excluded	SOMED 2006	(D16 + D16.0) / B03
INT	Average intensity of nursing	*Case-mix*: average intensity of nursing under FHIL (average time per patient day; minutes recorded into integers varying from 1 (1 to 20 minutes) to 13 (> 240 minutes);	SOMED 2006	V11 (FSO 2008b, p. 27)
SIZ (SIQ)	Size (square of size) with respect to number of beds	*Structure*: size (square of size) of facility with respect to the number of available long-term and short-term beds	SOMED 2006	B03
QUP	Qualified personnel per 100 beds	*Quality*: Number of qualified employees (medical doctors, qualified nurses) per 100 beds (full-time equivalents); OBS without qualified personnel excluded	SOMED 2006	(C.09.0 = 31 or 32) * 100 / B03
AUX	Patient-days per non-medical employee	*Standard*: Number of patient-days accounted per non-medical qualified employee; OBS over 1,825 days excluded as "outliers"	SOMED 2006	(D16 + D16.0) / (C09 – (C.09.0 = 31 or 32))
PUB	Legal form (dummy variable)	*Funding*: Legal form, private (regulated exclusively by company law) or public (regulated by administrative *and* company law);	SOMED 2006	0 < A17 < 11 ≥ private (= 0); 19 < A17 < 35 ≥ public (=1)
REG	Linguistic region (dummy var.)	Linguistic region of the nursing home: 0 = German; 1 = French, Italian or Romansh	SOMED 2006	A19 (A19 = 1 => REG = 0; A19 = 2 or 3 => REG = 1)
WAG	Wage level in canton	Monthly gross wage sector 85: healthcare and welfare in CHF	SAKE 2006	Assumption: cantons have same wage level as the "greater region"
RNT	Rent index in canton	2003 rent index by canton	Statistical Yearbook of Switzerland	See www.bfs.admin.ch
BED	Density of nursing home beds in the canton	Number of nursing home beds per 1,000 inhabitants aged 65 years or older	SOMED 2006 and ESPOP 2006	B03 and ESPOP at www.bfs.admin.ch

Figure 13: Histograms and normality tests for the per-bed costs items (viz., C^{TOT}, C^{ASS}, C^{MHI}) in nursing homes, 2006



Source: SOMED (FSO 2008a); calculations by the author.

Table 19: Regression results (detailed)

a) Dependent variable C^{TOT}

```
CTOT: Random intercept multilevel regression: xtreg command (GLS)
xtreg CTOT DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C, i(KTNR)
Random-effects GLS regression                 Number of obs      =      1186
Group variable: KTNR                          Number of groups   =        25
R-sq:  within  = 0.5392                       Obs per group: min =         5
       between = 0.7551                                      avg =      47.4
       overall = 0.6146                                      max =       199
Random effects u_i ~ Gaussian                 Wald chi2(10)      =   1427.86
corr(u_i, X)       = 0 (assumed)              Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CTOT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   112.3049   13.62704     8.24   0.000     85.59639    139.0134
       INT_C |   2807.231   247.0718    11.36   0.000     2322.979    3291.483
       SIZ_C |   .2866974   21.24321     0.01   0.989    -41.34922    41.92262
       SIQ_C |   .0698282   .0951322     0.73   0.463    -.1166274    .2562839
       QUP_C |   581.6223   29.39826    19.78   0.000     524.0028    639.2419
       AUX_C |  -22.75336   1.609602   -14.14   0.000    -25.90812    -19.5986
       REG_C |    2898.68   1881.723     1.54   0.123    -789.4294    6586.789
       WAG_C |   27.40342   11.28798     2.43   0.015     5.279389    49.52745
       RNT_C |   9.402718   10.91221     0.86   0.389    -11.98482    30.79025
       BED_C |  -169.7376   112.5556    -1.51   0.132    -390.3426    50.86739
       _cons |   79456.81   1585.764    50.11   0.000     76348.77    82564.86
-------------+----------------------------------------------------------------
     sigma_u |  6555.8727
     sigma_e |  11123.546
         rho |  .25780554   (fraction of variance due to u_i)
------------------------------------------------------------------------------


CTOT: Random intercept multilevel regression: xtmixed command (REML)
xtmixed CTOT  DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C || KTNR: , variance
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log restricted-likelihood = -12716.848
Iteration 1:   log restricted-likelihood = -12716.848
Computing standard errors:
Mixed-effects REML regression                 Number of obs      =      1186
Group variable: KTNR                          Number of groups   =        25
                                              Obs per group: min =         5
                                                             avg =      47.4
                                                             max =       199
                                              Wald chi2(10)      =   1408.45
Log restricted-likelihood = -12716.848        Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CTOT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   111.5419   13.56983     8.22   0.000      84.9455    138.1383
       INT_C |   2812.049   247.1215    11.38   0.000       2327.7    3296.398
       SIZ_C |   1.459467   21.16204     0.07   0.945    -40.01737    42.93631
       SIQ_C |   .0643149   .0947101     0.68   0.497    -.1213135    .2499433
       QUP_C |   580.6592   29.28147    19.83   0.000     523.2685    638.0498
       AUX_C |  -22.69443   1.603281   -14.15   0.000     -25.8368   -19.55206
       REG_C |   2178.378   1929.938     1.13   0.259    -1604.232    5960.988
       WAG_C |   27.60917   14.53217     1.90   0.057    -.8733581     56.0917
       RNT_C |   8.482337   13.55464     0.63   0.531    -18.08428    35.04895
```

```
      BED_C |   -183.014   140.8143    -1.30   0.194    -459.0048    92.97688
      _cons |   79407.24   2023.412    39.24   0.000     75441.43    83373.05
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
KTNR: Identity               |
                  var(_cons) |   7.35e+07   2.42e+07      3.85e+07    1.40e+08
-----------------------------+------------------------------------------------
               var(Residual) |   1.24e+08    5146378      1.14e+08    1.34e+08
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =   322.35 Prob >= chibar2 = 0.0000


CTOT: Random slope multilevel regression: xtmixed command (REML)
xtmixed CTOT  DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C || KTNR: WAG_C,
variance covariance(unstructured)
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log restricted-likelihood =  -12713.23
Iteration 1:   log restricted-likelihood = -12711.354
Iteration 2:   log restricted-likelihood = -12711.014
Iteration 3:   log restricted-likelihood =  -12711.01
Iteration 4:   log restricted-likelihood =  -12711.01
Computing standard errors:
Mixed-effects REML regression                   Number of obs      =      1186
Group variable: KTNR                            Number of groups   =        25
                                                Obs per group: min =         5
                                                               avg =      47.4
                                                               max =       199
                                                Wald chi2(10)      =   1487.76
Log restricted-likelihood =  -12711.01          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
       CTOT |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      DAY_C |   111.6951   13.54325     8.25   0.000      85.1508    138.2394
      INT_C |   2784.401   243.2617    11.45   0.000     2307.616    3261.185
      SIZ_C |   1.710444   21.00877     0.08   0.935    -39.46599    42.88688
      SIQ_C |   .0629845   .0942816     0.67   0.504    -.1218041    .2477732
      QUP_C |   579.8541   29.13341    19.90   0.000     522.7536    636.9545
      AUX_C |  -22.61019   1.599583   -14.14   0.000    -25.74532   -19.47507
      REG_C |   1788.546   1862.481     0.96   0.337    -1861.849    5438.941
      WAG_C |   61.06459   22.96623     2.66   0.008     16.05162    106.0776
      RNT_C |  -13.26339   11.24912    -1.18   0.238    -35.31127    8.784483
      BED_C |  -57.43818   94.85999    -0.61   0.545    -243.3603     128.484
      _cons |   82360.73   3184.886    25.86   0.000     76118.47    88602.99
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
KTNR: Unstructured           |
                  var(WAG_C) |   4701.522   3170.448      1253.819    17629.58
                  var(_cons) |   1.54e+08   7.05e+07      6.27e+07    3.78e+08
            cov(WAG_C,_cons) |   850572.8   474700.1     -79822.16     1780968
-----------------------------+------------------------------------------------
               var(Residual) |   1.24e+08    5135530      1.14e+08    1.34e+08
------------------------------------------------------------------------------
LR test vs. linear regression:       chi2(3) =   334.03   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
```

b) Dependent variable C^ASS[82]

```
CASS: Random intercept multilevel model: xtreg command (GLS)
xtreg CASS DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C, i(KTNR)
Random-effects GLS regression                   Number of obs      =      1186
Group variable: KTNR                            Number of groups   =        25
R-sq:  within  = 0.1484                         Obs per group: min =         5
       between = 0.4857                                        avg =      47.4
       overall = 0.2557                                        max =       199
Random effects u_i ~ Gaussian                   Wald chi2(10)      =    229.40
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CASS |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   60.22444   12.66393     4.76   0.000     35.40359    85.04529
       INT_C |   355.2498    227.761     1.56   0.119    -91.15354    801.6532
       SIZ_C |  -41.34839   19.72391    -2.10   0.036    -80.00655   -2.690241
       SIQ_C |      .1205   .0884313     1.36   0.173    -.0528221    .2938222
       QUP_C |   201.4407   27.30412     7.38   0.000     147.9256    254.9558
       AUX_C |  -13.34217   1.494838    -8.93   0.000      -16.272   -10.41234
       REG_C |   1157.589   1660.776     0.70   0.486    -2097.472    4412.649
       WAG_C |   18.40148   7.772107     2.37   0.018      3.16843    33.63453
       RNT_C |   10.70352    7.98815     1.34   0.180    -4.952968       26.36
       BED_C |  -86.59288   81.41559    -1.06   0.288    -246.1645    72.97875
       _cons |   43594.59    1108.77    39.32   0.000     41421.44    45767.74
-------------+----------------------------------------------------------------
     sigma_u |  4420.3021
     sigma_e |  10348.837
         rho |  .15429134   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

[82] Calculating the regression to C^ASS with a random slope model (all 3 group variables WAG, RNT, and BED were tested for this purpose) could not be managed by the software. Either the standard error calculations or performance of the gradient-based optimization in the REML routine failed.

c) Dependent variable C^{MHI}

```
CMHI: Random intercept model: xtreg command (GLS)
xtreg CMHI DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C, i(KTNR)
Random-effects GLS regression                   Number of obs      =      1186
Group variable: KTNR                            Number of groups   =        25
R-sq:  within  = 0.4834                         Obs per group: min =         5
       between = 0.8752                                        avg =      47.4
       overall = 0.6153                                        max =       199
Random effects u_i ~ Gaussian                   Wald chi2(10)      =   1259.25
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CMHI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   54.88216   10.20671     5.38   0.000     34.87737    74.88695
       INT_C |   2431.129   181.5665    13.39   0.000     2075.266    2786.993
       SIZ_C |   37.19282    15.8718     2.34   0.019     6.084671    68.30097
       SIQ_C |   -.032054   .0712775    -0.45   0.653    -.1717554    .1076474
       QUP_C |   380.4247   21.98124    17.31   0.000     337.3423    423.5071
       AUX_C |  -9.729753   1.203299    -8.09   0.000    -12.08818    -7.37133
       REG_C |   3739.918   1253.892     2.98   0.003     1282.336    6197.501
       WAG_C |   8.327369   4.776436     1.74   0.081    -1.034274    17.68901
       RNT_C |   .8760432   5.300129     0.17   0.869    -9.512019    11.26411
       BED_C |  -49.18894   53.22646    -0.92   0.355    -153.5109    55.13301
       _cons |   35956.49   694.6487    51.76   0.000        34595    37317.97
-------------+----------------------------------------------------------------
     sigma_u |  2638.0013
     sigma_e |  8374.3676
         rho |  .09027284   (fraction of variance due to u_i)
------------------------------------------------------------------------------


CMHI: Random intercept model: xtmixed command (REML)
xtmixed CMHI  DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C || KTNR: , variance
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log restricted-likelihood = -12373.099
Iteration 1:   log restricted-likelihood = -12373.099
Computing standard errors:
Mixed-effects REML regression                   Number of obs      =      1186
Group variable: KTNR                            Number of groups   =        25
                                                Obs per group: min =         5
                                                               avg =      47.4
                                                               max =       199
                                                Wald chi2(10)      =   1195.94
Log restricted-likelihood = -12373.099          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CMHI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   53.41107   10.18114     5.25   0.000      33.4564    73.36573
       INT_C |   2436.053   183.2546    13.29   0.000     2076.881    2795.225
       SIZ_C |   39.49194   15.85859     2.49   0.013     8.409674     70.5742
       SIQ_C |  -.0402588    .071093    -0.57   0.571    -.1795984    .0990809
       QUP_C |   382.1199    21.9526    17.41   0.000     339.0936    425.1462
       AUX_C |  -9.524077   1.201863    -7.92   0.000    -11.87969   -7.168469
       REG_C |   2861.187   1341.831     2.13   0.033     231.2459    5491.127
       WAG_C |   8.668279   6.402232     1.35   0.176    -3.879866    21.21642
       RNT_C |   .1245653   6.541797     0.02   0.985    -12.69712    12.94625
       BED_C |  -62.15998   66.74992    -0.93   0.352    -192.9874    68.66747
       _cons |   35929.32   911.9993    39.40   0.000     34141.83     37716.8
```

```
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
KTNR: Identity               |
                  var(_cons) |   1.35e+07    5096149       6430267    2.83e+07
-----------------------------+------------------------------------------------
               var(Residual) |   7.01e+07    2916061      6.46e+07    7.60e+07
------------------------------------------------------------------------------
LR test vs. linear regression: chibar2(01) =    90.05 Prob >= chibar2 = 0.0000


CMHI: Random slope model: xtmixed command (REML)
xtmixed CMHI  DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C || KTNR: WAG_C ,
variance covariance(unstructured)
Performing EM optimization:
Performing gradient-based optimization:
Iteration 0:   log restricted-likelihood = -12370.872
Iteration 1:   log restricted-likelihood = -12370.344
Iteration 2:   log restricted-likelihood = -12370.285
Iteration 3:   log restricted-likelihood = -12370.284
Iteration 4:   log restricted-likelihood = -12370.284
Computing standard errors:
Mixed-effects REML regression                   Number of obs      =      1186
Group variable: KTNR                            Number of groups   =        25
                                                Obs per group: min =         5
                                                               avg =      47.4
                                                               max =       199
                                                Wald chi2(10)      =   1277.25
Log restricted-likelihood = -12370.284          Prob > chi2        =    0.0000
------------------------------------------------------------------------------
        CMHI |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DAY_C |   52.68882   10.17517     5.18   0.000     32.74584    72.63179
       INT_C |   2425.882   179.7479    13.50   0.000     2073.582    2778.181
       SIZ_C |   39.43091   15.77495     2.50   0.012     8.512577    70.34924
       SIQ_C |  -.0415911   .0708699    -0.59   0.557    -.1804936    .0973114
       QUP_C |   381.1631   21.85468    17.44   0.000     338.3287    423.9975
       AUX_C |  -9.492116   1.201396    -7.90   0.000    -11.84681   -7.137423
       REG_C |   2813.769   1277.005     2.20   0.028     310.8862    5316.653
       WAG_C |   27.99028   9.101732     3.08   0.002     10.15121    45.82934
       RNT_C |  -4.821852   6.302097    -0.77   0.444    -17.17373     7.53003
       BED_C |   27.88011   56.15244     0.50   0.620    -82.17664    137.9369
       _cons |    37830.4   1327.269    28.50   0.000        35229     40431.8
------------------------------------------------------------------------------
------------------------------------------------------------------------------
  Random-effects Parameters  |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
KTNR: Unstructured           |
                  var(WAG_C) |   551.5017   511.2225      89.64233    3392.974
                  var(_cons) |   2.54e+07   1.31e+07       9252989    6.98e+07
            cov(WAG_C,_cons) |   118385.2   82876.34     -44049.39    280819.9
-----------------------------+------------------------------------------------
               var(Residual) |   7.01e+07    2915029      6.46e+07    7.60e+07
------------------------------------------------------------------------------
LR test vs. linear regression:       chi2(3) =    95.68   Prob > chi2 = 0.0000
Note: LR test is conservative and provided only for reference.
```

Table 20: Correlation matrix of regressors

corr DAY_C INT_C SIZ_C SIQ_C QUP_C AUX_C REG_C WAG_C RNT_C BED_C (obs=1186)

	DAY_C	INT_C	SIZ_C	SIQ_C	QUP_C	AUX_C	REG_C	WAG_C	RNT_C	BED_C
DAY_C	1.0000									
INT_C	0.0286	1.0000								
SIZ_C	0.0774	-0.0364	1.0000							
SIQ_C	0.0404	0.0171	0.9173	1.0000						
QUP_C	0.0555	0.4819	0.0349	0.0667	1.0000					
AUX_C	0.0416	-0.3587	-0.0609	-0.0387	-0.0425	1.0000				
REG_C	0.2012	0.5139	-0.0865	-0.0794	0.1172	-0.2879	1.0000			
WAG_C	-0.0783	-0.0599	0.0834	0.0903	-0.0007	0.0610	-0.1731	1.0000		
RNT_C	-0.0632	-0.1905	0.1298	0.0998	-0.0192	0.1544	-0.3985	0.6298	1.0000	
BED_C	-0.1552	-0.3605	0.0048	0.0303	-0.1470	0.1779	-0.5719	0.0621	0.0039	1.0000

6 Demography and the future requirements of inpatient acute care in Swiss hospitals

Abstract

An aging population may have a strong influence on future acute care hospital use in Western countries. Such concerns also exist for Switzerland and its 26 cantons. This article aims to empirically predict the range of national and cantonal acute care hospital volumes (i.e., hospital cases and hospital days) through 2030. A projection model is presented that makes a systematic link between Swiss hospital medical statistics and canton-level population scenarios. Medical technology and organizational progress are simulated in the model by making different assumptions about future lengths of stays in hospitals. Despite the aging of the Swiss population, the projections find that the increase in hospital days required through 2030 is not (or is only slightly) expected to exceed population growth. Although an increase in hospital days between 5 percent and 13 percent is predicted in the model, the Swiss population will grow 11 percent in the "average" demographic scenario.

6.1 Background

Switzerland is a small Western European country with a population of 7.9 million people (as of 2010) and a total area of 41,000 km^2. The country consists of 26 cantons, which differ considerably in area, population size, population density, and socioeconomic conditions (see Figure 2 and Table 12). The Swiss inpatient acute care hospital sector that is discussed in more detail in this article is well developed. It has costs of 17.3 billion CHF in 2010; this corresponds to a 28.3 percent share of the country's 61.0 billion CHF healthcare expenditure total. Compared to other (Western) OECD countries, Switzerland shows a rather average supply of 5.0 acute care hospital beds per 1,000 population[83] but traditionally measures an above-average length of stay (LOS) of 9.6 days in such hospitals[84].

The federalist political system in Switzerland delegates many public responsibilities to the canton level, including the implementation of healthcare policies and the provision of a sufficient supply of inpatient care services for their populations. To accomplish this task, the cantons should seek the best possible statistical information about the structure and the future trends in their populations and their actual and future patterns of hospital utilization.

In recent years, the Swiss cantons have increasingly used statistical information for making projections and for planning future hospital capacity (Weaver et al. 2009a). They often make use of the available data sources and calculate hospital capacity projections for their service area. However, many cantons still lack sufficient information about themselves and their neighboring regions (OECD/WHO 2011).

To introduce, this article provides a comparative overview of canton populations with regard to their demographic structures in 2010 and presents a short overview of projections of these structures through 2030; these are figures calculated by the Swiss Federal Statistical Office (FSO, 2012e). Moreover, an short overview of current inpatient acute care hospital utilization will be given for each canton. Finally, the estimates of future hospital utilization will be presented following different scenarios based on a projection model.

---

83 The corresponding indicators (2010) for selected countries are as follows: Germany: 8.3; Austria: 7.6; France: 6.4; OECD average: 4.9; UK: 3.0; New Zealand: 2.7; and Sweden: 2.7 (see OECD. 2013. "OECD Health Data Base." OECD. Paris.).

84 The corresponding indicators (2010) for selected countries are as follows: Finland: 11.6; Germany: 9.5; Belgium: 8.1; OECD average: 7.1; US: 4.9; Denmark: 4.6; Norway: 4.5 (see ibid.).

This projection model (see Section 6.2.2) had originally been developed by researchers at the Swiss Health Observatory and the Statistical Office of Canton Vaud (VD) (Cerboni and Camenzind 2006; Weaver et al. 2009a) for the statistical support of the hospital planning process in *individual cantons*. It uses an optimal combination of the two data sources, the Swiss hospital medical statistics (MS) (FSO 2011c) and the Swiss population statistics (STATPOP) (FSO 2010a, 2012e). Hence, the future requirements for inpatient hospital care is presented for each medical branch at the canton level.

As most of the cantonal healthcare authorities normally use these projections for their internal planning process, they are not available for the public. Therefore, this information about future requirements of inpatient acute care for all 26 individual cantons in Switzerland is presented the first time in this article. The other contribution of the article is a result of the *simultaneous application of the model for the 26 Swiss cantons:* direct comparisons of the results between cantons and the country as a whole as well as calculations of national-level results for medical branches are made available to the reader.

6.2 Materials and methods

6.2.1 Data sources

The Swiss population statistics (STATPOP) were used to measure the canton-level age structures of the resident population in 2010 and to project population trends through 2030 (FSO 2012e). For these purposes, the population was divided into younger (0 to 64 years) and older (65 years and older) residents. The year 2010 was the base year for the analysis, in alignment with the hospital data for 2010 (FSO 2012c), which was the most current data that was available upon the commencement of this work.

Three different projection scenarios are typically calculated in STATPOP. Only the middle scenario, the so-called "average" scenario, has been used throughout this article. This average STATPOP scenario assumes a continuation of the demographic trends of recent years and takes several factors into account, such as the introduction of free movement of persons within Europe (FSO 2010a). Moreover, STATPOP was used to calculate hospitalization rates; hospitalization numbers were set in relation to population numbers (Breslow and Day 1975).

The second data file, MS, consists of discharges from the Swiss national hospital discharge master file from 2010 (FSO 2012c). The 2010 file contains 1.1 million discharges (i.e., hospital cases) from acute care hospitals of individuals residing in the 26 Swiss cantons. The statistical units are individual hospital cases.

Discharges of patients who were not residents of Switzerland at the time of their treatment were excluded from the analysis, as were patients who had been discharged from psychiatric, geriatric, or rehabilitation hospitals and newborn children in obstetrics wards—the latter to avoid "double-counting" the hospital stays of mothers and children for births. Only inpatients who spent at least one night in the hospital in 2010 were included; all outpatient hospital cases were excluded from the analysis. Moreover, anonymous hash codes were used to identify hospital cases as returning individuals (i.e., "patients"; 0.8 million persons compared to 1.1 million hospital cases in 2010).

6.2.2 Statistical analyses

Descriptive analyses

The target variable of this article was the acute care hospital volume, which is the product of hospital cases and the average lengths of stay (LOSs). Thus, for the calculation and interpretation of LOS in hospitals, concepts very similar to those used to identify the number of patients and cases were adopted. The LOS for every case was calculated as the difference in days between the date of discharge and the date of admission plus one day. Because LOS data usually exhibit wide variance, are unevenly distributed, and can be distorted by certain individuals with excessively long hospitalizations when calculated in this manner, the median and percentile values (5, 25, 50, 75, and 95 percent) were used in the descriptive analyses (see Figure 17) instead of the arithmetic mean values (as for the model calculations). To achieve more robustness, the top 5 percent of cases with the longest LOSs are presented separately (see Appendix, Figure 21).

Estimation model

The statistical projection model for the future utilization of hospitals requires a systematic link between the MS (FSO 2012c) and the canton-level data from STATPOP (FSO 2012e). It is important to highlight that, for both the patient and population dimensions, the *canton of residence* is always the focus. In the projection model, hospitalization rates ($T_{a,k,j,2010}$) for age group "a," canton of residence "k," and All Patient Diagnosis Related Groups (AP-DRG) "j" in the base year 2010 were calculated first. These hospitalization rates ($T_{a,k,j,2010}$) were obtained by dividing the number of cases ($S_{a,k,j,2010}$) for every age-canton-DRG-group in 2010 by the resident population of this same age-canton-group ($P_{a,k,2010}$) in 2010.

$$T_{a,k,j,2010} = S_{a,k,j,2010} / P_{a,k,2010} \qquad (1)$$

Intra-cantonal and extra-cantonal hospitalizations were handled separately, but the ratios of these intra- and extra-cantonal hospitalizations (i.e., the patient flows) were held constant between 2010 and 2030; it is difficult to speculate about the development of these patient flows in the coming years[85]. Theoretically, 20 age groups, 26 cantons, and over 600 AP-DRG combinations result in more than 300,000 different $T_{a,k,j,2010}$ per base year (2010). In fact, most of the strata are empty, because many diagnoses are never coded by Swiss hospitals.

Next, the $T_{a,k,j,2010}$ were extrapolated using population coefficients ($P_{a,k,p,2030}$). The latter are estimates of the population trends according to the average population scenario "p" (FSO 2012e) through 2030 for each age group ("a") and canton of residence ("k"). Again, the intra-cantonal and the extra-cantonal population trends were considered separately. By subsequently summing these products across *all age groups*, the number of estimated cases ($S_{k,j,p,2030}$) of each AP-DRG ("j") in each canton ("k") was obtained according to the applied population scenario ("p") for the projected year (e.g., 2030):

[85] Until 2011, acute care hospital use was basically restricted to the canton of residence (except in medically indicated cases, in emergencies, or in the case of a policyholder having bought a particular complementary insurance). Since 2012, this "territorial" restriction has been suspended and, consequently, larger patient flows in the inpatient acute care hospital market can be expected. Centralization of highly specialized medicine is another point with an expected impact on acute care hospital patient flows in Switzerland in the years to come.

When using the model as tool for individual canton-level projections of future utilization and, particularly, when comparing these results with actual and future supply structures, hypotheses about the possible changes of patient flows have to be considered thoroughly. However, in the calculations presented in this article, this aspect is less important. The analyses here are limited to the demand side (i.e., the future utilization) of the acute care hospital markets. Whether patients will be treated in hospitals of their own residential canton or in another canton has no direct importance here.

$$S_{k,j,p,2030} = \sum (P_{a,k,p,2030} \; * \; T_{a,k,j,2010}) \qquad (2)$$

Keeping the $T_{a,k,j,2010}$ constant in the projection period using the age, canton, and AP-DRG values for the base year (2010) is an implicit application of the hypothesis of the extension of morbidity (Seshamani and Gray 2004). Therefore, the model is at clear risk of overestimating future hospitalizations. Moreover, the model has not yet been programmed to distinguish between hospitalizations of female and male patients. Varying developments for each sex can be taken into account neither in canton-level population trends nor in morbidity and mortality trends.

Various hypotheses on LOS trends are simulated in the model. These trends include *changes in the time* needed for medical treatment based on new therapies, new technologies, new medications, or more efficient processes. To this end, inlier and outlier cases are treated separately in the model. Inliers are the cases with LOS that do not exceed a given lower and upper limit for each AP-DRG in 2010. These limits are derived from the given definition of inliers and outliers in the FSO dataset of 2010: 78.5 percent of the cases are defined as inliers, 16.1 percent are low outliers, and 5.4 percent are extreme outliers (Schenker et al. 2008).

Concerning inliers, their average LOS, $MLS_{j,2010}$, is calculated as the sum of the LOSs of all *inliers* of individual AP-DRG “j” ($\sum LOS_{j,2010}$) divided by the number of inliers ($m_{j,2010}$) of this particular AP-DRG “j” in 2010. The average LOS of the outliers (21.5 percent of the cases of each AP-DRG) is calculated as well. In contrast to the inlier cases, the *outliers* are kept constant concerning their number and their LOS in all scenarios presented below. The hypothesis here is that these outlier cases will exist in the same form in 2030 as in 2010. Thus, there is speculation in the model neither about their future numbers nor about their average future LOSs. All results for the MLS, for inliers, and for outliers used in the following scenarios, reflect the exact *average* LOS values[86].

$$MLS_{j,2010} = \sum (LOS_{j,2010} / m_{j,2010}) \qquad (3)$$

[86] In the projection model, calculations of exact arithmetic mean values (not rounded integers!) are used. In contrast, the descriptive presentations of LOSs in Figures 16 and 20 show median and percentile values (i.e., integers for the 5, 25,50, 75, and 95 percentiles) were used (see Section 6.3.2).

Various hypotheses can now be adopted with regard to the future trends of the $MLS_{j,2010}$ for inliers per DRG-group "j". Four of these hypotheses are presented here. In the first hypothesis, the $MLS_{j,2010}$ for inliers (as is the case for outliers in all four scenarios) was kept constant for each DRG-group from the base year 2010 until the chosen projection horizon 2030 ($MLS_{j,2010} = MLS_{j,2030}$). Therefore, no technological or organizational progress occurred. This "*constant scenario*" was regarded as the *upper limit* for the estimates.

In the second hypothesis, $MLS_{j,2010}$ evolved in such a way that it was the same length in 2020 in all hospitals of all cantons as the 2010 value for the corresponding DRG-group in the hospital that had the *shortest* $MLS_{j,2010}$ in the country in 2010. Only the DRG-groups from hospitals with at least 25 inlier cases were taken into account for this purpose. It is important to emphasize that this assumption implies that the caseloads of the inlier cases within all DRG-groups of every hospital are identical. In other words, the differences in LOS between hospitals are not caused by differences in the health status of patients (within DRG-groups of inliers); they result only from the differences in the "production processes" of the hospitals. After 2020, $MLS_{j,2010}$ (resp. $MLS_{j,2030}$) for inliers did not evolve any further, and only population trends were taken into account between 2020 and 2030. This "*best scenario*" was regarded as the *lower limit* for the estimations.

The third hypothesis assumed that the $MLS_{j,2010}$ in all hospitals would be the same length in 2020 as the *second-shortest* $MLS_{j,2010}$ in a Swiss hospital in 2010 for the corresponding DRG-group ("j"). This circumstance was called the "*second-best scenario*". Again, only the hospital groups containing at least 25 inlier cases were taken into account. As in hypothesis 2, $MLS_{j,2010}$ resp. $MLS_{j,2030}$ did not evolve any further after 2020.

Finally, the fourth hypothesis assumed that the $MLS_{j,2010}$ in all Swiss hospitals in 2020 will be the same length as the $MLS_{j,2010}$ in the Swiss hospital that had an $MLS_{j,2010}$ corresponding to the *25th percentile* for the corresponding DRG-group in the base year 2010 ("*quarter-best scenario*"). Again, only hospital groups with at least 25 inlier cases were taken into account, and $MLS_{j,2010}$ ($MLS_{j,2030}$) did not evolve any further after 2020.

When converting the number of projected cases into the number of hospital days, the actual effects of these various LOS scenarios can be shown. Thus, the number of projected hospital days $J_{s,k,j,p,2030}$ was calculated by multiplying the number of cases $S_{k,j,p,2030}$ by the average LOS $MLS_{s,j,2030}$ according to the length scenario "s" and summing the products:

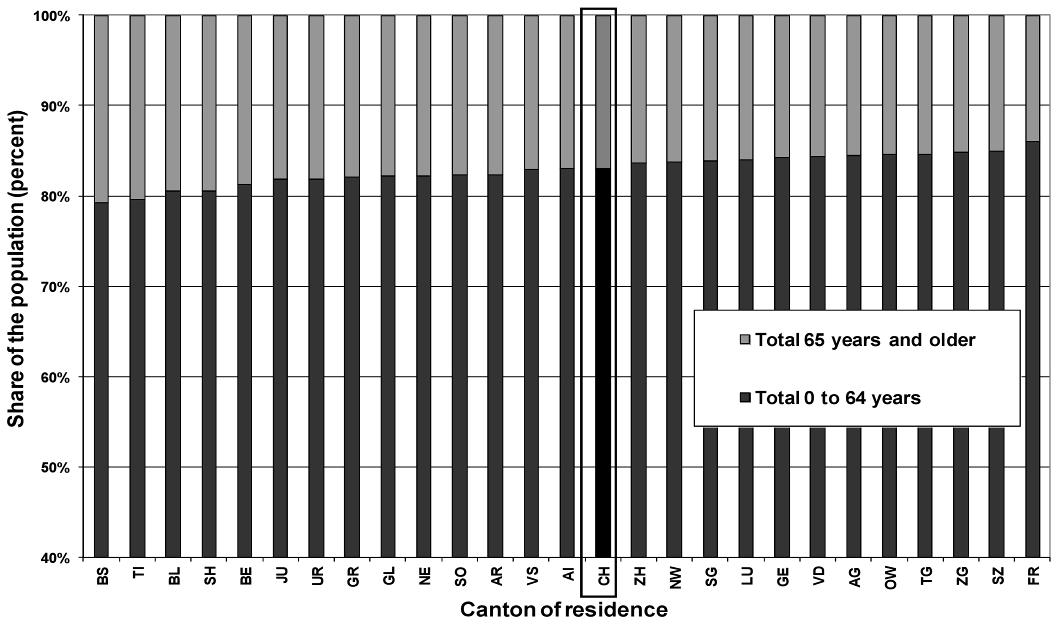
$J_{s,k,j,p,2030} = \sum (S_{k,j,p,2030} \ * \ MLS_{s,j,2030}).$ (4)

If the models were used to support concrete canton-level hospital planning, further assumptions about trends for the cantons' or the hospitals' specific bed occupancy rates would have to be made next. Again, various scenarios could be used for these purposes (Weaver et al. 2009a). After integrating specific occupancy rates into the model, estimates of the additional requirements (compared to actual *beds*) in the projected period can be made. In the present paper, however, this step has not been taken.

6.3 Results

6.3.1 Structures of and trends within the Swiss population

Figure 14: "Young" (0–64 years) and "old" populations (65+ years) by canton: shares of the total population in percentages, 2010

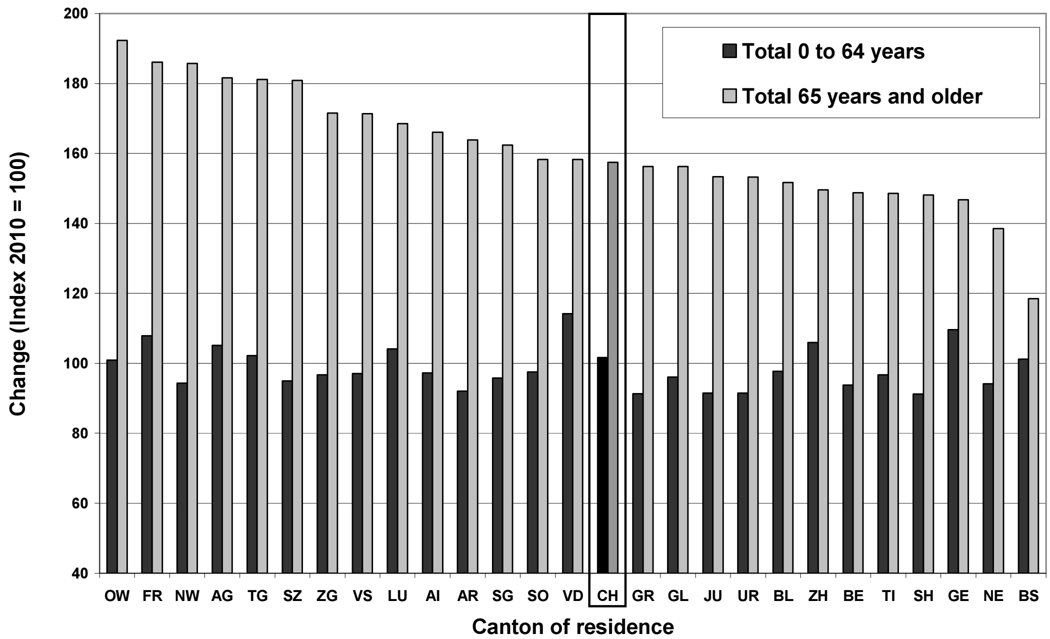


Source: Swiss Population Statistics STATPOP (FSO 2012e), personal calculations.

In the base year 2010, the total population of Switzerland (CH) was 7.9 million people. Of these, 6.5 million (83 percent) were younger than 65 years old, and 1.3 million (17 percent) were 65 years old or older (see Figure 14). The proportion of older residents varied across cantons and ranged from 14 percent to 21 percent.

The official demographic projections (FSO 2012e) indicate that the Swiss population will increase by 0.9 million people (11 percent) from 2010 to 2030. The group of young residents will grow by approximately 2 percent, and the number of older residents will grow considerably more, by 57 percent (see Figure 15). Major differences are also expected for individual cantons. In some of the smaller cantons (Obwalden OW, Fribourg FR, and Nidwalden NW), the older population will increase by 85 percent or more, while increases between 40 percent (20 percent in BS) and 80 percent can be expected in the other cantons (see Figure 20 in the Appendix for the projected distribution of the cantonal populations in 2030).

Figure 15: "Young" (0-64 years) and "old" (65+ years) populations by canton: change index, 2010–2030



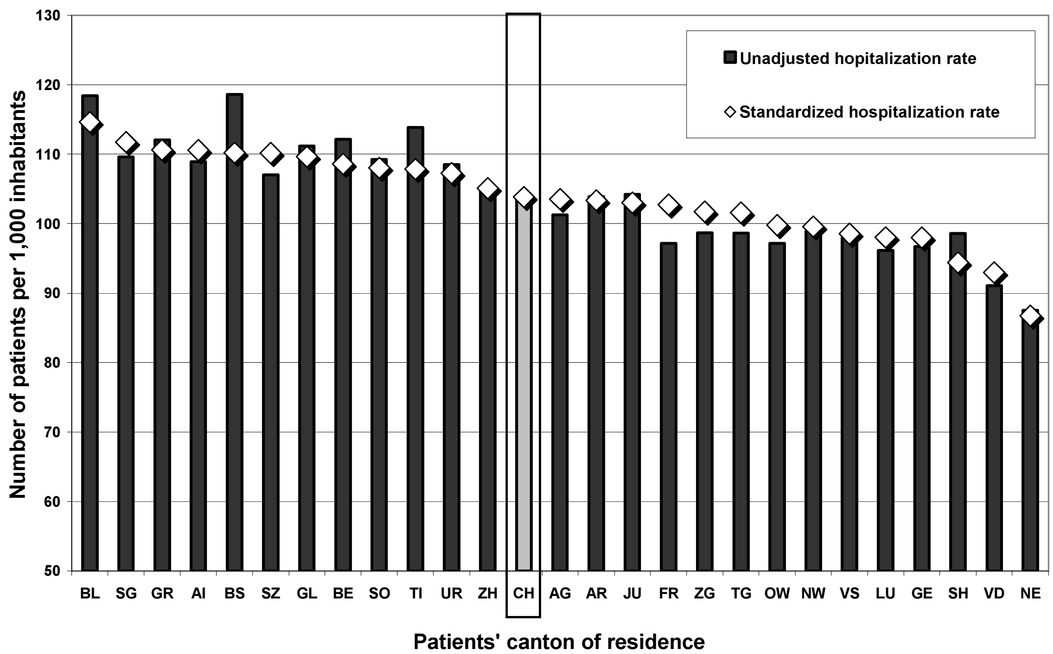
Source: Swiss Population Statistics STATPOP (FSO 2012e), personal calculations.

6.3.2 Utilization of Swiss inpatient acute care hospitals, 2010

A total of 209 somatic acute care hospitals were in operation in Switzerland in 2010 (FSO 2012c). These hospitals treated 1.1 million cases of illness, accident and maternity and 0.8 million different patients. In relation to the resident population, 104 patients were treated for every 1,000 inhabitants in 2010 (see Figure 16). Clear differences were found between the cantons, with unadjusted hospitalization rates ranging from 88 to 119 patients per 1,000 residents. Age and gender standardization did not have a strong influence on these hospitalization rates across the cantons (see Figure 15).

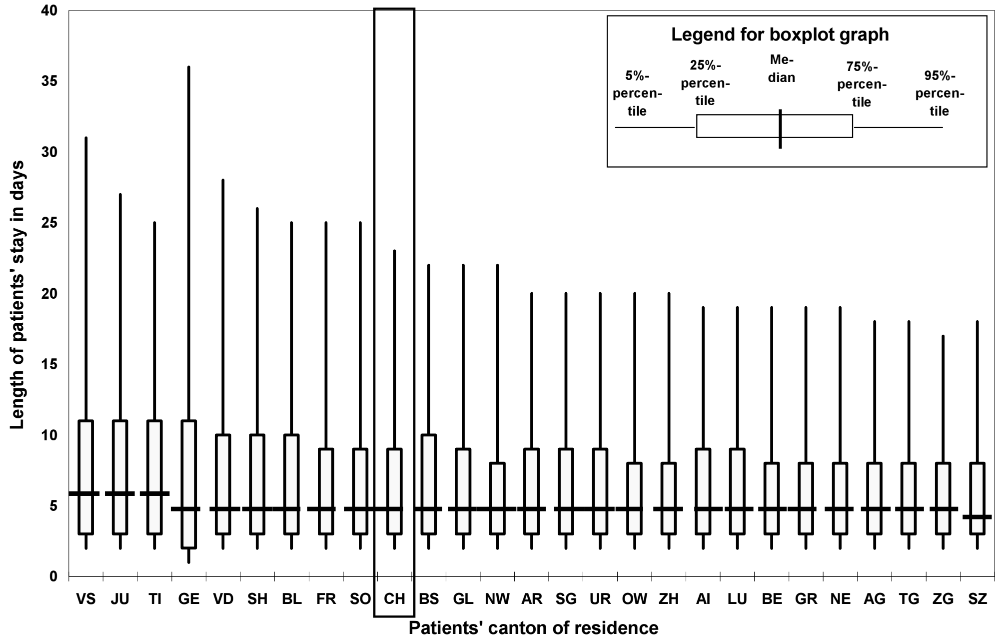
Reviewing the LOS data for Swiss acute care hospitals reveals three cantons (Valais VS, Jura JU, and Ticino TI) with a six-day median LOS, which is an above-average LOS. The values for almost all other cantons match the national median (CH) of 5 days, and one canton (Schwyz SZ) has a median LOS of 4 days (see Figure 17). When the cantons are ordered by the median LOS *and* by the duration of the 75th percentile as the second priority—as shown in Figure 17—six other cantons (Geneva GE, Vaud VD, FR, Schaffhausen SH, Basel-Landschaft BL, and Solothurn SO) are ranked above the Swiss average (CH).

Figure 16: Acute care hospitalizations by canton: patient frequencies, 2010



Source: MS (FSO 2012c) and STATPOP (FSO 2012e), personal calculations.

Figure 17: Inpatient acute care hospital cases* by canton: length of stay, 2010



* Inpatient acute care (A-) cases in 2010 (N = 1,104,128 cases)

Source: MS (FSO 2012c), personal calculations.

The 5 percent of the hospital cases with the longest LOS in Switzerland include approximately 51,000 cases. The average LOS for these cases is 23 days, with a median value of 33 days (see Appendix, Figure 21). In individual cantons, the median values for the top 5 percent of length-intensive hospital cases vary between 30 days (TI, St. Gallen SG, and Bern BE), and 37 days (GE and OW). Three-quarters of these "long-term" hospital cases (approximately 38,000 cases nationwide) have a LOS between 23 and 45 days. The remaining quarter of cases (75th percentile; 13,000 cases) were in the hospital for 46 days or more.

6.3.3 Estimates of hospital cases and days by canton through 2030

The application of the projection model enables one to simultaneously see the influences of the canton-level population structures and trends and the canton-level hospital utilization patterns on the future utilization of hospitals through 2030. Figure 18 shows that the projected percentage change in the number of hospital *cases* for the entire country (CH) between 2010 and 2030 is approximately 20 percent, an increase from 1.06 million to 1.27 million hospital cases.

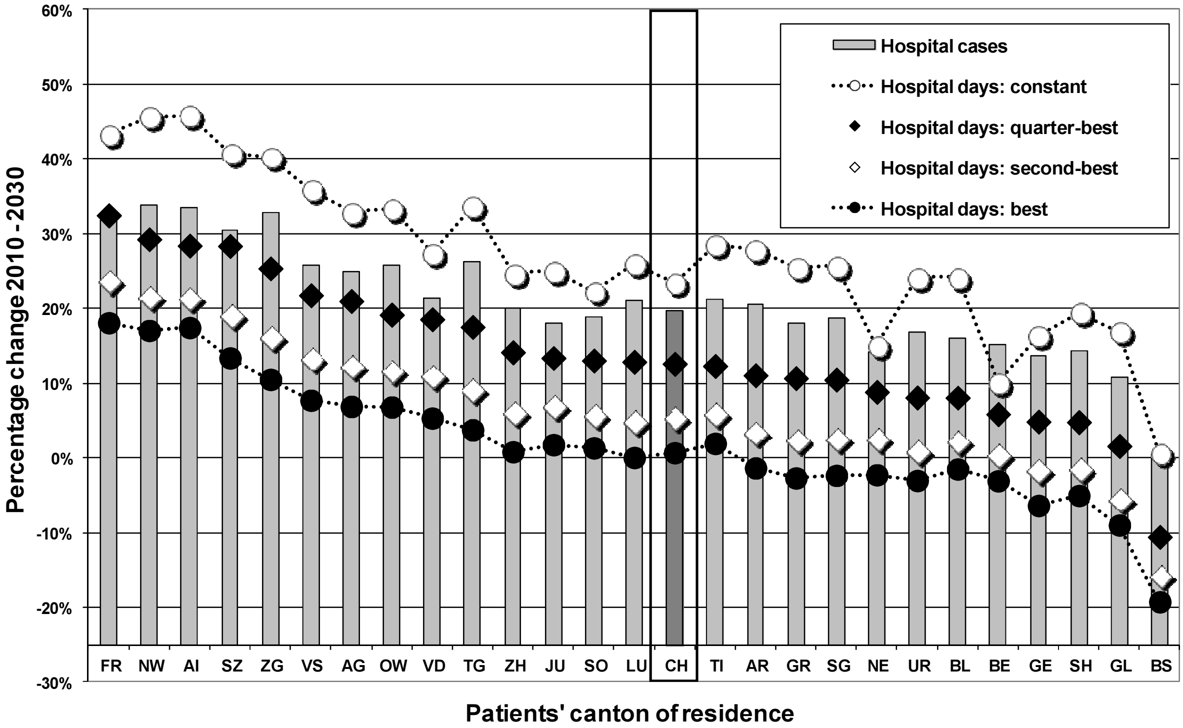
Differentiation by canton shows that some Swiss cantons (NW, Appenzell Innerrhoden AI, Zug ZG, FR, and SZ) will be confronted with an above-average increase (30 percent to 34 percent) in hospitalizations of their resident population by 2030. This result coincides with the fact that these cantons will experience relatively strong increases in their older populations between 2010 and 2030 (see Figure 15). Most of these cantons had relatively moderate hospital utilization rates in the base year 2010 in terms of frequency and LOS. But there is a rise in utilization rates after age-standardizing the rates in most of these cantons (see Figure 16).

Nearly all Swiss cantons with relatively small forecasted increases (15 percent or less) in hospital cases (Basel-Stadt BS, Glarus GL, GE, Neuchâtel NE, SH, and BE) were among those with the smallest expected increases in the size of the older population in the next 20 years (see Figure 15). However, hospital utilization in the base year 2010 was less uniform than the age structure for these cantons (see Figures 16 and 17). NE had both relatively low hospitalization rates and relatively short LOSs, while GE and SH had relatively low hospitalization rates but relatively high LOSs. Finally, there were cantons (BE, BS, and GL) with relatively high hospitalization rates, but LOSs in 2010 that were "average" (BS and GL) or quite short (BE).

Regarding the projection of hospital days required in 2030, Figure 18 indicates the results of the four scenarios: "constant," "best," "second-best," and "quarter-best." The two scenarios "best" and "constant" had been introduced as lower and upper limits for the hospital day projections (see Section 6.2.2). For the entire country (CH), these lower and upper projection limits correspond to a 1 percent and 23 percent increase, respectively, in hospital days between 2010 and 2030.

The two other scenarios—the more optimistic "second-best" scenario and the less optimistic "quarter-best" scenario—predict increases in hospital days of 5 percent and 13 percent, respectively, for the entire country (CH) by 2030. Across the 26 cantons, the results for the estimates of hospital days in the "second-best" and the "quarter-best" scenarios are almost uniformly 8 percentage points apart. Only the latter scenario is discussed in the following Section.

Figure 18: Hospital cases and days (four scenarios) by canton: percentage change, 2010–2030



Source: MS (FSO 2012c) and STATPOP (FSO 2012e), personal calculations.

The "quarter-best" scenario predicts an increase from 8.20 million to 9.23 million hospital days (13 percent) for the entire country (CH) between 2010 and 2030. The greatest canton-level increases in hospital days are 25 percent or more (in rather small cantons, such as FR, NW, AI, SZ, and ZG). For other cantons (BS, GL, SH, and GE), the reverse holds true; they can expect a change in their future requirements for hospital days between -11 percent and 5 percent.[87]

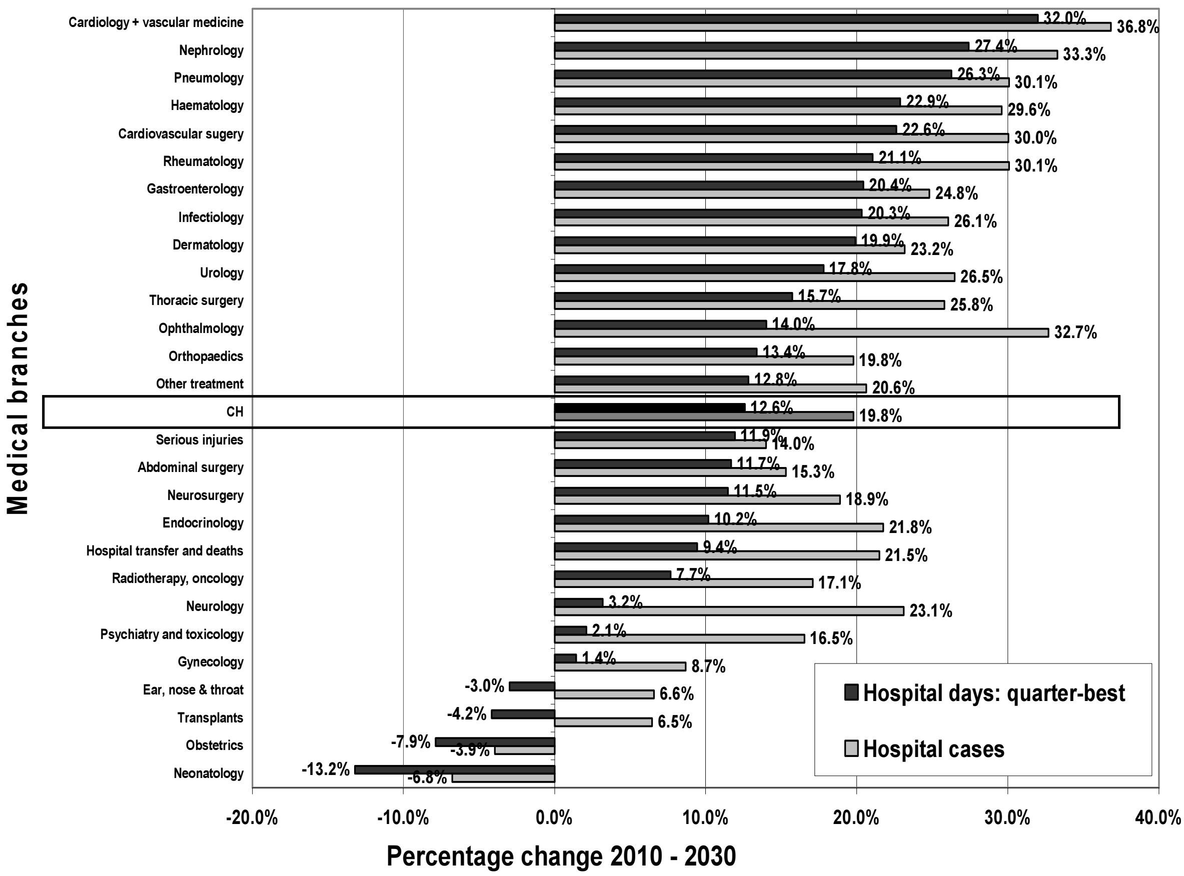
The relatively large difference between hospital cases and hospital days predicted by the model indicates good potential to shorten the future LOS in hospitals. Appenzell Ausserrhoden AR, BS, Thurgau TG, and ZG are cantons for which this potential had not been visible in the "isolated" observation of LOS in Figures 17 and 21 (Appendix).

[87] In the "second-best" scenario, all these cantons could expect a decrease in their future requirements for hospital days.

6.3.4 Estimates of hospital cases and days by medical branch through 2030

If the nationwide trend in hospital cases is stratified according to 27 different *medical branches* (Gesundheitsdirektion 2009), the influence of demography on these branches becomes apparent (see Figure 19). With an overall increase of 20 percent in the number of *hospital cases*, medical branches with predominantly elderly patients, such as cardiology and vascular medicine, nephrology, ophthalmology, pneumology, rheumatology, or cardiovascular surgery, can expect increases of 30 percent or more. At the other end of the scale, medical branches with exclusively very young patients, such as neonatology and obstetrics, show decreases in hospital cases between 4 percent and 7 percent.

Figure 19: Hospital cases and days ("quarter-best" scenario) by medical branch: percentage changes, 2010–2030



Source: MS (FSO 2012c) and STATPOP (FSO 2012e), personal calculations.

The volume of inpatient care that will actually be required in different medical branches of the Swiss somatic acute care hospitals through 2030 can be better described with the projections for required *hospital days*. For these projections, the “quarter-best” scenario[88] is used to predict trends in LOS. The number of overall hospital days (CH) increases by 13 percent (see also Figure 18).

Relatively large increases in hospital days (between 32 percent and 26 percent) can be observed in the aforementioned branches of cardiology and vascular medicine, nephrology, and pneumology (see Figure 19). Ophthalmology, however, does not remain in the group. Although the model forecasts an increase of 33 percent in the number of cases, the number of hospital days is estimated to grow only 14 percent by 2030 in the “quarter-best” scenario. This result indicates—under the assumption that the patients grouped in the DRGs of this medical branch create similar caseloads across all hospitals—relatively high potential to shorten the LOS in this medical branch in the future. Finally, medical branches with very young patients, such as neonatology and obstetrics, remain at the low end of the scale. The expected reduction in the number of hospital days in these two medical branches is estimated to be -8 percent to -13 percent in the “quarter-best” variant.

6.4 Discussion

6.4.1 Population: canton- and age-specific structures in 2010 and 2030

Considerable differences are present in the age structures of the cantons’ populations. In 2010, the national share of the older population (aged 65 years or older) was 17 percent, but the rates varied distinctively among the cantons from 14 percent to 21 percent. In addition, the older population will increase more in the future than will the younger population (under 65 years old). Between 2010 and 2030, the older population will increase 57 percent for the whole country and between 19 percent and 92 percent among the 26 Swiss cantons. Consequently, in 2030, more than 24 percent of the Swiss population will be people aged 65

[88] See Section 6.2.2. The “quarter-best scenario” assumes that the average LOS of every individual DRG in all Swiss hospitals in 2020 will be the same length as the average LOS corresponding to the 25th percentile for the corresponding DRG-group in the base year 2010 (for hospital groups with at least 25 inlier cases).

years and older. In the individual cantons, this proportion will vary between 20 percent and 29 percent.

6.4.2 Hospital utilization in 2010: frequency, age structure, and LOS

The descriptive analysis of hospital utilization across the cantons in 2010 indicates strong regional variations. The canton with the highest hospitalization rate (BL, standardized by age and gender) registered approximately one-third more hospitalizations per capita in 2010 than the canton with the lowest rate (NE). In addition to epidemiologic reasons, these variations can be associated with socioeconomic characteristics of the population, such as social deprivation and poverty (Camenzind 2012; Reich et al. 2011; Schleiniger et al. 2007; Strunk et al. 2002). Regionally varying healthcare provision structures and medical practice variations (Borowitz 2010) of different healthcare providers are other important factors that may influence the utilization of acute care hospitals (Wennberg 1987).

As for the relationship between higher age and healthcare utilization and costs, it should be remembered that economists have warned for almost three decades about being naïve in interpreting the connection (Evans 1985). Because chronic illnesses are more likely to accompany old age, it is reasonable to assume higher utilization of healthcare services and higher healthcare costs as a nation's population ages. However, older age does not have a uniform influence on the utilization of healthcare service domains such as ambulatory care, hospital care, pharmacy services, or long-term care (Bayer-Oglesby and Höpflinger 2010; Mangano 2010). Other authors have shown that an aging population has a large effect on long-term care but less of an effect on the utilization of acute inpatient care (Spillman and Lubitz 2000). Second, the time remaining before individuals' deaths has been reported to be a much stronger explanatory factor of varying individual healthcare costs than simple age (Felder et al. 2000; Felder and Werblow 2008; Seshamani and Gray 2004; Weaver et al. 2008; Werblow et al. 2007). It can be shown that this "proximity to death effect" can influence hospital costs as far out as 15 years before death (Seshamani and Gray 2004).

For a better understanding of what these concerns mean for the estimates presented here, the actual causes of population aging must be specified (Weaver et al. 2009b). First, a population can become older if its life expectancy increases. In the estimation model used in this study, the middle scenario from STATPOP (FSO 2010a) assumes an increase in life expectancy at birth from 79 to 85 years for men and from 84 years to 89 years for women between 2010 and 2050. Because such growth is certainly not negligible, the argument about "proximity to death" could be partially valid for the projections calculated here. If this type of population aging does *not* lead to more illnesses and disabilities (i.e., if the hypothesis of "healthy aging" or "compression of morbidity" is valid), the future utilization of hospital inpatient services predicted by this study might be overestimated (Seshamani and Gray 2004).

On the other hand, an aging population is a result of large age cohorts (e.g., the "baby boomer generation") becoming older and being followed by smaller cohorts of young people (i.e., a shrinking society in the long run). In these cases, the "proximity to death argument" is not valid. As the demographic reality in Switzerland indeed reflects this pattern as well, the overestimation of the future hospital utilization in the presented projections due to neglecting "healthy aging" is less important.

In addition to hospitalization frequency, LOS is the other important indicator for describing the volume of acute care consumed by a resident population. For 95 percent of all Swiss hospital cases, the LOS indicator did not practically vary across cantons in 2010. Three-quarters of all hospital stays lasted no longer than nine days at the national level and no longer than 11 days at the level of individual cantons. The most interesting hospital cases are the 5 percent (i.e., 51,000 cases) with the longest LOSs in 2010. Their share of the total volume of hospital days in 2010 was 25 percent or 2.30 million of the 8.72 million days spent in Swiss acute care hospitals. This "inequality" is even more pronounced at the canton-level. In the most "unequal" canton (GE), the 10 percent of cases with longest LOSs (of more than 23 days) were responsible for 49 percent of the total acute care hospital days. An additional, more precise empirical analysis of these cases could show whether all these patients are rightly being treated in acute hospital care. For suitable patients, preference could be given to treatments in nursing homes or to outpatient services.

6.4.3 Future utilization of acute care hospitals in Switzerland

The baseline scenario for the model calculations (i.e., hospital days being held constant), for which LOS remains unchanged from 2010 to 2030, shows a 23 percent increase in hospital days for the country as a whole. If "corrected" for the expected population increase of 11 percent in the same period, this result corresponds to an increase of 12 percent in hospital days as a result of the predicted demographic changes (i.e., the population aging). However, the underlying assumption that the LOS will remain unchanged between 2010 and 2030 is hardly realistic. With technological or organizational progress and changes in the funding structure for hospitals (Busato and von Below 2010; Widmer and Weaver 2011), shorter LOSs are likely.

If the more realistic but rather conservative "quarter-best" scenario is applied, then hospital days will increase 13 percent by 2030 at the national level. Nevertheless, some cantons (FR, NW, AI, and SZ) will still face increases of approximately 30 percent in hospital days, whereas other cantons (GL, SH, and GE) can expect an increase of less than 5 percent in hospital days under the "quarter-best" scenario. One canton (BS) is in an even better position, expecting a decline of 11 percent by 2030 in the "quarter-best" scenario.

The detailed projection results also show varying, age-specific changes in the utilization of medical branches. Specialties that typically serve older patients, such as cardiology and vascular medicine, will clearly be more necessary in 2030 than medical branches with very young patients, such as neonatology or obstetrics. The prediction model is capable of showing these varying trends for medical branches or even individual AP-DRGs for each canton separately.

6.4.4 Strengths and limitations

Regional-, age-, and gender-specific variations in hospital utilization have been extensively described in the literature (Fisher et al. 2003; Fisher et al. 2000). In Switzerland, variations have been demonstrated for specific treatments (Matter-Walstra, Widmer, and Busato 2006; Schöni-Affolter, Widmer, and Busato 2008; Widmer et al. 2009). Compared to this previous research, the major innovation of this study is that the presented model describes and projects future regional variations in *overall* somatic acute care hospital utilization. It takes into account the individual diagnoses of the patients (AP-DRGs), existing (and time-invariant) patient flows between cantons, and estimates of technological and organizational progress. The model combines this information with age- and canton-specific population structures and trends on the most detailed level possible. The results show how hospital utilization in one canton will develop in comparison with other cantons and with the country as a whole.

Nevertheless, this study has several limitations. More intense canton-level future hospital utilization may be a consequence of above-average hospital utilization in 2010, above-average growth in the older population between 2010 and 2030, or both. The above-average canton-level growths of the population 65 years or older dominate the calculations of hospital days in the favored “quarter-best” scenario. The “second-best” or even the “best” scenario gives more influence to the changes in medical treatment caused by new therapies, new technologies, new medications, or more efficient processes. Moreover, if a shorter prediction period is chosen—until 2020 instead of 2030, for example—the influence of demographic trends is less dominant. Hence, appropriately balancing the two main influencing effects in the model, demography and changes in medical technology and treatment, is not a simple task.

Another weakness of the present work reflects the limitations of its data. The MS do constitute an exhaustive survey; therefore, they are not subject to any distortions, but the data only reflect reality when the coding is correct. The quality of the data and the possible presence of errors are constant issues in these statistics, just as they are in other countries' data. Moreover, demographic projections and scenarios are of limited value, because they will only become reality if the proposed hypotheses (FSO 2010a) actually occur.

In addition to the general difficulty mentioned above in balancing demographic and medical technology trends, various other assumptions (Weaver et al. 2009a) that may influence the results had to be made to produce the presented estimates. For example, an identical caseload was assumed for every DRG-group across every Swiss acute care hospital. Moreover, the hospitalization rates were held constant over time, whereas medical and technical progress was only taken into account in terms of LOS and not in terms of the prevalence of certain illnesses. One of the consequences of this latter limitation, which certainly overestimates the future requirements for acute care hospital services in the results of the model, has already been mentioned. Finally, future preferences and the future structure of the demands for acute care hospital services among the population were left completely unchanged through 2030.

More generally, these limitations may differentially contribute to an endogeneity problem[89] in the projection model. The model is certainly oversimplified, with just two “independent” variables—viz., the actual hospital utilization rates and the population trend coefficients. It is

[89] See also Chapter 1 of the thesis.

quite obvious that—aside from these 2 factors—many other variables will influence future hospital utilization as well. Moreover, the analysis also suffers from an inherent selection bias: omitting relevant regressors and selection bias are both important sources of endogeneity. The other two important causes of endogeneity—simultaneous causalities and measurement errors in independent variables—seem less important.

6.4.5 Conclusions

Although this work only addresses consequences on the acute care hospital sector, the existence of cantons with pronounced aging population trends raises questions about whether such population trends should be "corrected" with instruments of family support, tax, immigration, or other regional policies. The Swiss cantons that will suffer relatively large declines in their younger populations are mostly small cantons in peripheral regions. Thus, it should be decided at the Confederation level whether these cantons can be left alone with their demographic problems or whether policies should be developed at the national level. It should also be carefully examined whether the concerned cantons excessively attract wealthy older people with particular tax policies, thus contributing to their own problem.

Cantons with above-average frequencies or above-average LOSs of actual and future hospitalizations should conduct more detailed empirical analyses to determine the precise reasons for their "heavy use" of inpatient acute health care. A search at the level of individual AP-DRGs like the one presented in the projection model could be helpful toward this end. Moreover, such an analysis might compare the acute care hospital utilization of the canton's population with actual health indicators and health behavior in the canton, as well as with the structure and practices of the canton's healthcare system. Precisely for this purpose, regional health reporting (Heeb et al. 2011) has been developed over the last few years in Switzerland.

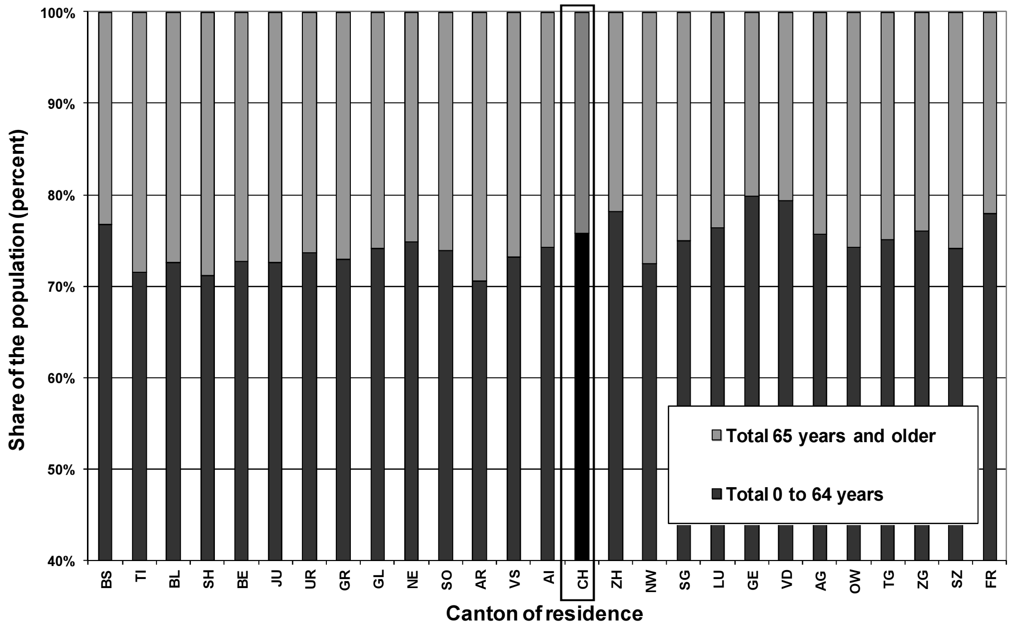
Appendix, Chapter 6

- **List of abbreviations used**

OECD: Organization of Economic Cooperation and Development; WHO: World Health Organization; MHI: mandatory health insurance; CHF: Swiss francs; FSO: Swiss Federal Statistical Office; (AP-) DRG: (All patients) diagnosis related groups; LOS: Length of stay (in hospitals); MS: Swiss medical statistics of hospitals; STATPOP: Swiss population statistics; CH: Switzerland; AG: Aargau; AI: Appenzell Innerrhoden; AR Appenzell Ausserrhoden; BE: Bern; BL: Basel-Landschaft; BS: Basel-Stadt; FR: Fribourg; GE: Geneva; GL: Glarus; GR: Graubünden; JU: Jura; LU: Lucerne; NE: Neuchâtel; NW: Nidwalden; OW: Obwalden; SG: St. Gallen; SH: Schaffhausen; SZ: Schwyz; SO: Solothurn; TG: Thurgau; TI: Ticino; UR: Uri; VD: Vaud; VS: Valais; ZG: Zug; ZH: Zurich.

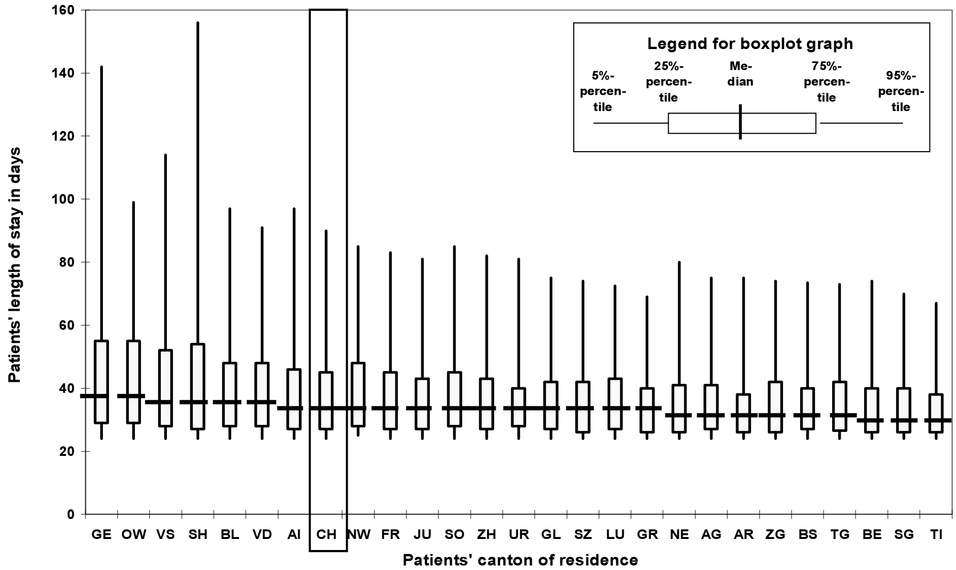
• Additional material

Figure 20: "Young" (0–64 years) and "old" (65+ years) populations by canton: shares of the total population in percentages, 2030



Source: Swiss Population Statistics STATPOP (FSO 2012e), personal calculations.

Figure 21: Inpatient acute care hospital cases* by canton: lengths of stay, 2010 (5 percent of all cases with the longest lengths of stay in 2010)



* 5 percent of all inpatient acute care (A-) cases with the longest LOSs at national level, 2010 (N = 51,072 cases)
Source: MS 2010 (FSO 2012c), personal calculations.

Part III: Concluding remarks

7 Concluding remarks

Part I of this thesis provides an introduction to the institutional and empirical framework referring to cantonal variations in costs and utilization of healthcare services in Switzerland Therefore, a short theoretical introduction is offered by presenting important aspects of the meaning of health care in the framework of health economic theory. This is followed by a presentation of the main components comprising the construction, functioning and funding of the Swiss healthcare system. Part I continues with an overview on Switzerland's health data situation and ends with a presentation of the literature overviewing international and national differences in regional healthcare costs.

In Part II of the thesis, three models on cantonal variations in actual and future utilization or costs of health service domains in Switzerland are presented. The utilization differences of six individual MHI service domains (Chapter 4), the per-bed cost differences in the nursing home sector (Chapter 5), and the future requirements of inpatient healthcare days in acute care hospitals (Chapter 6) are analyzed. Varying statistical methods (panel econometrics, multi-level regressions, and model simulations / projections) are used for these analyses. Finally, a synthesis of these detailed analyses is presented in the form of a discussion of the results obtained for two exemplary cantons (see Excursus after Section 7).

Investigating these manifold aspects of regional variations in utilization and costs of healthcare services in Switzerland generated interesting answers and insights to the research questions on the subject. However, as is normal in such a process, many more questions arose during the work. Rather concrete propositions, made in the discussions or conclusions of the three empirical articles in Part II of the thesis, are briefly repeated in the following paragraphs.

In the *first article* about variations in the utilization of services in six provider domains, more sophisticated methodological approaches were proposed to better address the serious, extant endogeneity problems. Instrumental variables and two-stage least squares estimation are the key words for these approaches (Stadelmann 2011). Another possibility could be the aggregation of several individual variables to form more general indices (e.g., creating an index for “social deprivation” instead of solely using the unemployment rate). A step towards more interpretative possibilities in the form of *direct causal inferences* could thus be taken. Concerning *data,* a closer look at more detailed domains of health service providers would be possible, whereas analyses of variations on more detailed geographical levels—districts or municipalities—would be productive, but not possible for data (protection) reasons.

In the *second article* about per-bed costs in Swiss nursing homes, it had been admitted that the use of a cross-sectional multilevel model was not the best choice and that better variables for the hospitality standard and different cantonal regulations in the nursing home branch should be modeled. Moreover, data at the level of individual nursing home clients (but without cost indicators) could be used. A (fixed-effects) panel data model with additional regressors of this nature would contribute to better control for unobserved heterogeneity of the cantons. Finally, a new variable for hospitality standard of the nursing homes could be proposed to the FSO, the producer of the SOMED data.

The *third article* implicitly applied the hypothesis of the extension of morbidity in the model (i.e., holding hospitalization rates constant over time with risk of overestimating future hospitalizations). Moreover, it reflected the impossibilities of taking into account varying developments for each sex with respect to canton-level populations, morbidity and mortality trends (taken into account only in terms of the LOS); future changes in patient flows were mentioned as further limitations. It would actually be possible to program the model in a way that these additional variables could be integrated and that simulations of different variants could be calculated. It would be much more difficult to integrate potential changes in preferences of the population for future acute care hospital services. Finally, the hospital cases with very long LOSs could be analyzed more precisely to see whether these patients are rightly being treated in acute hospital care.

One important societal phenomenon that was present across all articles of the thesis was the effect of an aging population on healthcare costs and utilization. It would be interesting to learn more about the reasons for the differences in actual and future age structures of cantonal populations. Without political countermeasures, shares of up to 29 percent of the population being 65 years and older are to be expected in some Swiss cantons until 2030. This could lead to increases of up to 30 percent in required acute care hospital days depending upon the specific canton. Apart from such increases, all cantons must consider large structural changes:

acute care treatments typically serving older inpatients will clearly be in greater demand in 2030 than those serving younger patients. Moreover, an aging population certainly not only affects (inpatient) acute health care but also more inpatient and outpatient long-term care.

This trend underlines the importance—particularly for cantonal authorities—to know more about the concrete consequences of such regional *population (age) structure changes* for future healthcare utilization. A possible contribution could also come from more research efforts on the effects of health prevention and promotion measures on health behavior and the future health status of elderly people. Promising models[90] for simulating such quantitative calculations are being developed in Western countries. The data situation seems to allow an application of these models to the contemporary Switzerland.

[90] See, for example: ArchimedesInc. 2012. "The Archimedes Model" [accessed on 2012]. Available at: http://archimedesmodel.com/archimedes-model, DYNAMO-HIA. 2010. "DYNAMO-HIA: a Dynamic Model for Health Impact Assessment" [accessed on 2010]. Available at: http://www.dynamo-hia.eu/root/o14.html, StatisticsCanada. 2012. "The Population Health Model (POHEM)" [accessed on 2012]. Available at: http://www.statcan.gc.ca/microsimulation/health-sante/health-sante-eng.htm#a2.

Excursus: an applied synthesis of the results for two exemplary Swiss cantons

The analyses in Chapters 4 to 6 were limited in their validity either to one single funding source (MHI) or to an individual health service provider domain (nursing homes and acute care hospitals). Moreover, these results were presented and discussed as universally valid results for all Swiss cantons. In contrast, the aim of this Excursus is to gain a synthetic and concrete understanding for what these results could mean for two exemplary cantons. Obwalden (OW) and Geneva (GE) are selected for this purpose because of their extreme positions[91] of aggregated healthcare expenditures[92] per capita.

Canton Obwalden (OW)

OW is situated in the central, German-speaking part of Switzerland. It is a small and rural canton with quite limited economic resources compared to the country's average. In spite of this relative "poverty," the rates of unemployed persons and those on social benefits are among the lowest in the country[93]. The actual age structure of OW is rather favorable: the percentages of those over 65 years and over 85 years are smaller than the national averages (see Figure 14). However, the share of persons suffering from chronic health problems—one out of three persons as of 2007[94]—was the highest in Switzerland. The mortality rates are around the country's average.

Canton OW's healthcare supply system is characterized by an average density of GPs, only a few specialists being active in the canton, a large share of drugs self-dispensed by physicians in private practice, a high share of outpatient hospital costs relative to total outpatient costs, just a few acute care hospital beds, and few pharmacies in its territory. A relative large share

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91 Canton GE shows the highest per-head costs of all cantons in 2007 (CHF 7,500; see Figure 5 & Table 4); OW (CHF 3,600) is in the second-to-last position behind the canton AI; because AI has no nursing home on its territory (see Chapter 5), OW was selected instead of AI.

92 Sum of MHI costs, state subsidies, and out-of-pocket expenditures, per capita (see Table 4).

93 Unemployment: annual average in 2007 of 1.3 percent in OW, compared to a 2.8 percent average across Switzerland (see SECO. 2011. "AVAM – System der Arbeitsmarktvermittlung und der Arbeitsmarktstatistik." Bern: Staatssekretariat für Wirtschaft (SECO).). Socail benefit recipients: Annual average 2007 of 1.1 percent in OW, compared to 3.0 percent for Swiss average (see FSO. 2013c. "Schweizerische Sozialhilfestatistik." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).

94 Source: FSO. 2011f. "Schweizerische Gesundheitsbefragung." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).

of MHI services is bought in other cantons. The price index for MHI services inside the canton (Schleiniger et al. 2007) is around the national average.

Out-of-pocket funds for healthcare services in OW are—compared to other cantons—low in absolute numbers and in relation to MHI expenditures (see Table 4). The amount of state subsidies corresponds to the expected number with respect to the MHI expenditures (see Figure 6). Instead, more people than in other cantons hold a CHF 300 standard deductible, and a very small but growing number of policyholders are participating in managed care plans.

The general trends for the entire country—increasing trends for outpatient drugs, nursing homes, and outpatient hospital services and declining trends for inpatient hospitals, GPs, and specialists in private practice (see Table 9)—are only partly observable in OW. Utilization has intensified for drugs and for outpatient services of GPs and hospitals. However, utilization of specialists, hospital inpatient consultations, and nursing home services has remained stable.

The detailed analysis of the nursing home branch shows that, institutions situated in OW are characterized by an above-average bed occupancy rate and a relatively large share of privately owned nursing homes. Other indicators, such as the size of the nursing homes, the qualifications of the personnel, the share of women in the cantonal population, and the cantonal private home rent index, are more or less at the Swiss average level (FSO 2011d).

One finds a below average nursing intensity in OW's nursing homes, a relatively low-level supply of formal outpatient long-term care (Spitex) and—in accordance with its young population—a relatively small share of women in the population. These cantonal healthcare supply and demand structures are associated with per-bed costs in OW's nursing homes that are close to the Swiss average for all three analyzed cost items: the annual per bed total costs, the annual per-bed costs for accommodation and assistance, and the annual per-bed costs for mandatory nursing under FHIL.

In the analysis of the actual situation and future developments in the acute care hospital sector, the relatively young population structure of OW becomes visible as well. OW has below-average rates for both unadjusted and standardized acute care hospital utilization. The LOS in OW's acute care hospitals is shorter than in the entire country, but the median value for the 5 percent cases with the longest LOS in OW (150 cases in 2010) is the highest in Switzerland (together with canton GE, see Figure 21).

OW's relatively young population structure proves to be much less favorable when projected into the future. Up to 2030, the number of residents over 65 will almost double (+92 percent) while the number of residents younger than 65 will remain almost unchanged (+1 percent, see Figure 15). The aging population of OW also translates into future requirements of acute care hospital capacities. The number of acute care hospital *cases* is expected to increase 26 percent, and the number of acute care hospital *days* is projected to rise approximately 12 percent in the two "middle" variants of the model simulations (see Figure 18).

Canton Geneva (GE)

The second canton more concretely discussed, Geneva (GE), is situated on the border with France in the French-speaking part of Switzerland. Concerning population numbers, GE is a medium-sized canton (see Table 12). Its type of settlement is clearly urban, and GE has an above-average economic power (see Figure 7). This characterization does not prevent the canton from facing the highest unemployment rates in the country[95] and high rates of social benefit recipients.

In addition to its rather favorable actual age structure—the percentage of those over 65 and 85 is smaller than in the national average—GE's population change through 2030 will be rather positive as well. The number of residents over 65 will increase less than 50 percent, and the number of residents younger than 65 will grow by 10 percent between 2010 and 2030 (see Figures 14 and 15). The share of persons suffering from chronic health problems is *below* (FSO 2011f), and the mortality rate is *around* the national average (FSO 2011e).

The healthcare provision system of canton GE is characterized by an average density of GPs and a high density of specialists. A very small share of self-dispensed drugs, an average share of outpatient hospital costs compared to total outpatient costs, a slightly above-average density of acute care hospital beds, and the second highest density of pharmacies (behind canton Ticino (TI)) can be observed. GE runs one of the five Swiss university hospitals. Only a small part (approximately 5 percent) of all MHI services for GE residents are administered

[95] Unemployment: Annual average in 2007 of 6.3 percent in GE, compared to 2.8 percent for Switzerland on average (see SECO. 2011. "AVAM – System der Arbeitsmarktvermittlung und der Arbeitsmarktstatistik." Bern: Staatssekretariat für Wirtschaft (SECO).). Socail benefit recipients: Annual average 2007 of 3.8 percent in GE, compared to 3.0 percent for Swiss average (see FSO. 2013c. "Schweizerische Sozialhilfestatistik." *BFS Aktuell.* Neuchâtel: Swiss Federal Statistical Office (FSO).

by providers outside the canton. The average price for MHI services is clearly above the national average (Schleiniger et al. 2007).

In canton GE, the amount of healthcare services funded by out-of-pocket payments is large in absolute numbers and also in relation to the (high) MHI costs (see Table 4). The amount of state subsidy is greater than the expected number (see Figure 6). More people than in other cantons hold high deductibles, and only a few policyholders are participating in managed care plans.

The general trends for the entire country—increasing trends in outpatient drugs, nursing homes, and hospital outpatient services and declining trends in inpatient hospitals, GPs, and specialists in private practice (see Table 9)—are partly observable in GE. Utilization has intensified for drugs and hospital outpatient services. It has remained rather constant for GPs, for specialists, and for nursing homes. Over the last few years, its inpatient hospital services have declined.

The specific analysis of the nursing home branch shows for the institutions situated in canton GE a clearly above-average bed occupation rate. There are more privately owned nursing homes than public nursing homes. The average size of a nursing home is around the national Swiss average of 61 beds. However, the intensity of nursing and the qualification of the personnel in GE's nursing homes are clearly above the national average.

The share of women in the cantonal population and the levels of home rents and salaries are higher than in other parts of the country. This is in particular true as well for formal outpatient long-term care supply (Spitex), which is—behind Basel-Stadt (BS)—the second-best developed in the country. The resulting annual per-bed costs in GE's nursing homes in 2006 are more than 50 percent higher than the national Swiss average (CHF 126,000 for GE versus CHF 80,000 for CH). Annual per-bed costs for MHI care and for accommodation and assistance contribute to a similar extent to this large difference (see Figure 12).

The analyses and the projections in the acute care hospital sector show for canton GE modest acute hospital utilization rates and LOSs beyond the national average. There is a rather favorable actual population-age structure and a positive development of this structure until 2030. The five percent of hospital cases with highest LOSs (6,900 cases in GE in 2010, see Figure 21) are among the longest LOSs in the country. As a consequence of this situation, the number of hospital *cases* in GE will increase by relatively modest 14 percent until 2030. The number of hospital *days* will increase by 5 percent in the quarter-best variant or even decrease by -2 percent in the second-best variant (see Figure 18).

Synthesis for the two exemplary cantons

An attempt to assign OW and GE to a health system related *typology* of Swiss cantons is proposed to complete the applied synthesis of the two exemplary Swiss cantons. This is done with reference to the basic model of effects for Switzerland proposed in this work (see Figure 1). Interrelations with cantonal healthcare costs and utilization are summarized in this model by four groups of influence factors on health and health care: the population and patients (demand), the healthcare provision system (supply), the healthcare financing system (funding), and the political system (decision) [96].

Concerning the demand-side effects, rural canton OW could be named a canton with an "*integrated population.*" In other words, the residents of OW live in relatively modest economic conditions. However, society is able to keep the economic exclusion of individuals—e.g., unemployment or dependence on social benefits—on a low level. The self-rated physical health status of the population is rather low. This might reflect more people being active in physically demanding jobs. The positive (i.e., young) age structure of the population will clearly deteriorate in the next 20 years. The tendency toward having fewer children will not be compensated by the immigration of young persons from other cantons or abroad. A relatively strong expansion of the future requirements of hospital acute care services has to be expected.

The urban canton GE could be labeled a canton with a "*globalized population*". This refers to an economic system that gives a large part of the population very good economic prosperity. Some share of the people—a larger part than in the "integrated population" cantons—cannot follow the demands of such a dynamic economic system. Higher rates of unemployment and social benefits collection serve as indicators for this. The self-rated physical health of the population is above average. However, for mental health, the opposite phenomenon occurs (Schuler and Burla 2012). The canton is able to keep its positive age structure for the next 20

[96] The political (decision) system is not discussed in the following paragraphs.

years, mainly because of the immigration of young people. The future requirements of hospital services in 20 years will be at today's' level.

On the supply side, the two different types of cantonal healthcare schemes—as they had been described in a former Swiss study (Haari et al. 2002)—can be repeated: canton OW reflects the "*peripheral-type scheme*" of a cantonal health provision system. This is focused on primary care and nursing homes. Supply and utilization of specialist services is restrained and replaced by (partly extra-cantonal) outpatient hospital services. With its modest health provision infrastructure (hospitals, pharmacies) on its territory, OW allows direct distribution of medicines by physicians. OW buys a large share of healthcare services in other cantons. OW's nursing home sector is well developed and has relatively healthy patients. Otherwise, the supply of Spitex services in the canton is relatively small.

Canton GE shows the "*center-type scheme*" of a regional healthcare provision system. A university hospital—or a large principal hospital in similar cantons—is surrounded by large numbers of independent specialists. Consequently, the share of outpatient hospital costs on total outpatient costs is lower than in peripheral cantons. There are many pharmacies selling drugs and medical devices. The share of drugs dispensed by physicians is small. Rather average densities of GPs and of acute care hospital beds are more characteristics of such a type of canton.

Moreover, a center-type scheme canton such as GE produces most of its health services internally. Very few MHI-funded services are "imported" from outside the canton. The prices for MHI-funded services are higher than for the nation on average. The nursing home sector is rather underdeveloped in terms of its density of beds. The relatively few patients treated in the nursing homes require a high intensity of care. For healthier patients, well-developed Spitex services are available.

The dimension of funding effects on costs and utilization has been less worked out in this thesis than the demand and supply effects. One can still try to introduce typical notions for the corresponding systems of cantons OW and GE: OW's healthcare funding system could be called a "*premium-oriented*" system. In other words, the share of healthcare expenditures financed by MHI premiums (i.e., by the individual policyholders) is relatively high[97]. GE's healthcare funding system could be called "*subsidy-oriented.*" In addition to high MHI premiums, the share of state subsidies is clearly above the expected level (see Figure 6).

[97] The share of MHI-financed costs for OW is 64 percent of its total costs (Table 4). The corresponding value for GE is 50 percent, and the average Swiss value (CH) is 55 percent.

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