1. Introduction

As different as existing health care systems may be, the challenges are very similar. Economic growth usually lags behind the growth of health care expenditure in most OECD-countries. Therefore, governments either look for new financing options, or they try to economize on costs or place greater burden on the patient. Quality should not suffer, but rather be increased by technological progress.

![Total health care expenditure](image)

**Figure 1.1: Total health care expenditure.**

Notes: CAN = Canada, G = Germany, UK = United Kingdom, U.S. = United States of America.
Source: OECD Health Data.

Comparing the US, Canada, Germany and the United Kingdom (figure 1.1) shows a similar picture with respect to growing health care expenditure. In 1970, the UK’s annual spending on health care was 4.5 percent of GDP, followed by Germany with 6 percent, Canada and the US each with 7 percent. Nearly 40 years later, in 2007, the share in health care expenditure rose to 8.4 percent in the UK, 10.4 percent in Germany and 10.1 percent in Canada. With 16 percent, the US is top-ranked and far ahead of all other countries.
In political debates, health care expenditures are often equated with health care costs. The tenor of health care costs is to contain them. But what is behind the growth of health care expenditure? An increase in health care expenditure can be attributed to various causes. It could be a change in the structure in demand as induced, for example, by a demographic change of an aging society. It can be inefficiencies in the provision of health care that drive costs. Last but not least, it can also be technological progress such as new medical devices or new drugs, which, apart from increasing health care expenditure, brings along persistent improvements in health care.

The US not only spend a lot of money on health care provision, but also spend a lot on the promotion of technological progress. The US is the prime innovator in health. Most Nobel prize winning laureates in medicine either are American scholars, or scholars who work in the US. The majority of patents generated in medicine are assigned to the US, and the diffusion of innovative products and technologies is highest there, too.

Cost-intensive medical imaging technologies, such as Magnetic Resonance Imaging (MRI) or Computed Tomography (CT), are most frequently used in the US. No country employs more MRIs and CTs (see figure 1.2 and 1.3). The costs involved are twofold. First, the purchasing and maintenance costs of such imaging technologies are quite high and so is their scope of application. Second, besides diagnosing diseases and injuries more precisely, they additionally allow the discovery of new disease patterns and thus open up new ground for further innovations.

When contrasting the growth of health care expenditure (figure 1.1) with
the employment of such innovative technologies, it becomes obvious that
there ought to be a positive correlation between health care expenditure and
technological progress (figures 1.2 and 1.3).

While considered as a positive driver of growth in most other sectors,
technological progress in medicine usually disappears in the ‘health-care-cost-
explosion’ discussion. Policy makers are preoccupied with fighting inefficien-
cies and less concerned with the nature of technological progress. But as far as
an increase in health care costs may be attributed to technological progress, it
is to be expected, since medical progress improves a society’s health standard.

![Graph showing CT scanners per million population](image)

**Figure 1.3:** Number of Computer Tomography scanner units.

Notes: CAN = Canada, G = Germany, UK = United Kingdom,
U.S. = United States of America.
*Source:* OECD Health Data.

Efficiency-improving policy measures have priority on most health care
agendas. Canada, Germany and the UK have highly regulated health care
systems with an average share in public spending of 73 percent, 79 percent and
85 percent, respectively. To fight bureaucracy-induced inefficiencies, more and
more free market elements are introduced into health care systems, since the
basic idea of a perfect market promises an optimal state of society’s well-being.
We may draw on Adam Smith’s idea of the invisible hand, suggesting that self-
interested actors who maximize their utility automatically work for the good
of society, given no externalities and no other kind of market failures. Insofar
the American health care system should not only be credited for its prolific
innovative potential, but also for its strong market orientation, although with a
42 percent-share in public spending on health, the US do not entirely leave the
job of health care provision to the market, either. But does it actually induce an
allocation of health care resources which is desirable for society?

Suppose the American health care system was the most efficient one,
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since the invisible hand is effectively at work. Furthermore, suppose that the increase in health care expenditure would be only caused by technological progress. Still, the question which would remain is, whether the market result corresponds to society's wants. Utility and profit maximizing behavior of the actors in a health care system need not necessarily coincide with an optimal health care provision of society. Not all that can be sold, although it might bear a subjective utility, will be legitimized by medical necessity.¹

Equivalently, inventive or innovative behavior of actors in the health care sector could be driven by profit maximization rather than by medical necessity. Thus, the research and development of profitable drugs would be preferred to more essential drugs. A medication to remedy Malaria would help a lot of people in poorer countries but drug sellers would face a low level of purchasing power. In this case, a purely market-driven innovation process would counteract the social target to improve the general health standard of society.

Potential years of life lost, females

Figure 1.4: Potential years of life lost (females).

Notes: CAN = Canada, G = Germany, UK = United Kingdom, U.S. = United States of America.
Source: OECD Health Data.

Using various measures, such as life expectancy, infant mortality or 'potential years of life lost (PYLL)', several approaches try to measure the effectiveness of health care systems. The measure 'potential years of life lost (PYLL)', for example, calculates the number of lost life years of a patient with respect

¹Aside from that, it seems to be very unlikely that 'health' can be reduced to the consumption of tradable medical goods and services in the first place. Not all health-relevant decisions are coordinated by markets such as the decision to work out or just do nothing.
to his life expectancy, while taking into account the causal disease. With this simple measure, a comparison of health care systems, whether they manage to improve a society's general well-being, can be made. In this vein, figure 1.4 compares the potential years of life lost regarding a country's female population and the causes of death according to the International Classification of Diseases (ICD). All four countries have managed to improve the general state of health care provision. Taking only this criterion into account, the American health care system performs poorest. The potential years of life lost is the highest. Weighting PYLL with the density of practising physicians per 1000 inhabitants in order to take into account the potential of a country's health care provision, the picture does not change much (see figure 1.5). The degree of improvement in terms of society's well-being remains lowest in the US, in comparison to the other countries.

![Potential years of life lost, females (weight: density of physicians)](image)

**Figure 1.5: Potential years of life lost (females). Weighted by practising physician density.**

Notes: CAN = Canada, G = Germany, UK = United Kingdom, U.S. = United States of America.

Source: OECD Health Data.

Though this comparison does not deliver sufficient evidence, it points out the basic difficulty in designing an efficient and innovation-promoting health care system. To what extent can we expose health care to the self-organizing power of markets without compromising a socially desirable health care provision? What impact do efficiency-augmenting market elements have on the inventive/innovative behavior of actors in the health system? If so, are there differences in the impact of market forces between the phases of the innovation process? Answering those questions would mean taking a

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2See Haenszel (1950), Doughty (1951) and also Friman et al. (1989) for calculating PYLL.
step forward in balancing the main topics in health policy in terms of cost-containment, financing, efficiency and technological progress.

The literature in health care economics usually focuses on efficiency, cost containment and financing. An applied version of the discussion about innovation and technological progress can be found in health technology assessment, which is due to the idea of medical-evidence based medicine. A theoretical and methodological discussion of the innovation process in health, which would investigate the interdependence between health markets and inventive/innovative behavior in medicine, has so far been neglected.

This book tries to fill this gap and contributes to a theory of innovation in health. To accomplish this, a methodological discussion has to be undertaken, since the ‘invisible hand’ is an ‘ailing’ metaphor with respect to the coordination of health care markets. Above all, health has to be conceptualized in a broader manner, which goes beyond a pure commodity perspective on health that inadequately reduces the debate to medical care markets. This addresses similar methodological issues as in the topic of innovation. The assumption of neoclassical equilibrium – the traditional, methodological translation of the ‘invisible hand’ – seems to be as misleading in health-relevant decision making as in the conceptualization of innovative behavior.

Evolutionary or Neo-Schumpeterian economics offers a lot of concepts and ideas to shed light on both topics. Their focus is primarily put on the attempt to grasp the dynamics of economic change as an endogenous element in economic behavior. Apart from that, little has been done so far to integrate such evolutionary concepts into the context of health.

This work elaborates on evolutionary and Neo-Schumpeterian concepts to deliver a promising approach to the analysis of innovation and health. A methodological framework will be developed which allows for a full integration of ‘health’ into economic theorizing. Based on this platform, the different phases of the innovation process – invention, innovation and diffusion/imitation – will be discussed. Examples of modeling will be provided to illustrate how to apply the developed methodological frame and translate theories of innovation and health into economic models. Thereby, neoclassical elements will not be rejected categorically, but employed at suitable places so that an integrative approach results.

1.1 Plan of the Book

Chapter 2 gives a concise overview of neoclassical as well as evolutionary or Neo-Schumpeterian concepts in economics. It touches the story of the ‘invisible hand’, how it was translated into neoclassical equilibrium theory,
and why the latter is considered static and not adequate to investigate economic change. Furthermore, the sources of evolutionary thinking in economics, which basically build on the critique of the static approach of neoclassical equilibrium analysis, will be briefly discussed to give the reader a rough idea about the basic differences between evolutionary approaches. This is done to pay tribute to various thinkers who contributed to evolutionary economics, since no comprehensive methodological framework exists, yet.

Chapter 3 aligns health care economics to the discussion in chapter 2 and illustrates, aside from the difficulties in introducing innovation into equilibrium analysis, the challenge of dealing with the topic ‘health’ within a pure market concept. The market mechanism is based on tradable commodities and actors who are able to evaluate their subjective utility in order to make an optimal choice subject to individual budget constraints. Besides complete information and capabilities of actors, in order to lead to an optimal outcome in terms of the overall well-being of society, the tradeability of goods is a requirement for the price mechanism to function in the first place. To integrate health in such a framework, one should consider health as a commodity. But this in fact comprises only medical care markets and does not capture all health-relevant aspects in human behavior.

For a broader concept of health, two distinctive approaches will be discussed: the subjective utility approach and the objectified needs approach. To a large extent, the subjective utility does not apply to health care provision. When medical experts decide on what a patient needs, demand is determined by objectified needs rather than by the subjective evaluation of the patient’s utility. On these grounds, health is classified with respect to marketability, and the distinction of subjective utility and objectified needs to give a comprehensive view on health.

Chapter 4 develops a methodological framework to investigate the innovation process in health by discussing ontological as well as methodological questions. Human behavior is perceived as rule-based behavior. The decision-making process is the interpretation of ‘generic’ rules which end up in ‘operant’-level observable actions and actualizations. This interpretative operation can lead to optimal behavior, but will have manifold interpretations under true uncertainty, as will be the case in innovative and health-related behavior. Doing this, it is argued that optimization as suggested in neoclassical approaches is just a special case of generic-rule interpretation, but it is a rare event and, as a rule, hardly applies to the context of innovation and health. This framework will then be applied to the three phases of the innovation process, invention, innovation and diffusion, in subsequent chapters.

Chapter 5 concentrates on the phase of invention and provides a first application of previous reflections. Medical researchers create new knowledge by combining existing pieces of knowledge. The impact of markets on inventive
behavior in basic science is negligible, since the academic career of medical researchers, who do basic research, follows the goal of being first in medical discovery rather than market profits. True uncertainty makes the invention process in basic research impossible to conceive as a market-pull approach. Inventive behavior, as performed in basic science, cannot be assumed to be optimal behavior. Actors need to interpret generic rules to perform inventive actions. In this vein, the ‘Seceder model’, used as a model of knowledge creation, puts an explicit focus on the generic level of such behavior.

Chapter 6 elaborates on the generic level of network evolution. A survey on the organizational form of research in German hospitals and research institutes delivers some propositions to model the evolution of medical research networks in medicine. The model stresses the part of network evolution, which is usually considered as a random part. Determinants of the actors’ network behavior that will be discussed are: the newness of novel research fields, local proximity of actors to existing networks and the role of social imitation. A percolation model will be used to study this process. Additionally, the interplay between the generic and the operant level is explained, and some empirical evidence is provided to support the idea of operant-level selection by markets.

To round off the work, the diffusion of two competing medical technologies is laid out in chapter 7. It exemplifies the institutional context in which the adoption of new medical technologies takes place. Based on a case study of heart medicine, the adoption behavior of medical experts with regard to a new heart technology is modeled using a simulation model. The actors are heterogeneous in preferences, learn by using a new technology, and are influenced by network externalities, whereas innovators follow different strategies such as price setting, or they enter the market at different stages. The results of this duopoly model thus describe various diffusion patterns of technologies.

The last chapter 8 sums up ideas, concepts and findings and proposes possible future research areas.