The Linked World: Working Paper Series

Towards Comprehensive Measurement of ICT's Impact: Measuring the Impact of ICT on Health Care

By
Robbin te Velde, Jesse Bos, and Reg Brennenraedts (Dialogic)

About The Linked World Project

Information and communication technology (ICT) has decisively established itself as a general purpose technology—one that affects an entire economy. Over the past four decades, ICT has spurred dramatic changes that will continue for the foreseeable future. Harder to predict, though, is the exact nature of those changes, and how they will play out across societies—in our economies, our cultural relationships and the way human beings interact.

This notion formed the basic motivation for embarking on the study, which the Telefónica Foundation agreed to underwrite in 2008. The purpose of *The Linked World: How ICT Is Transforming Societies, Cultures, and Economies* is to take stock of our knowledge on what the economic, social, and cultural impacts of ICT will be. How has it evolved, how much have we been able to quantify or to evaluate in a qualitative sense, and what does it mean for the challenges and opportunities ahead?

The Linked World: How ICT Is Transforming Societies, Cultures, and Economies is the result of a two-year global research project led by The Conference Board and underwritten by the Telefónica Foundation.

This working paper is one of a global series that forms the basis of the book *The Linked World: How ICT Is Transforming Societies, Cultures, and Economies* published by the Telefónica Foundation and Artel Press.

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Impact of ICT on Production of Goods and Services: Measuring the Impact of ICT on Health Care

By Robbin te Velde, Jesse Bos, and Reg Brennenraedts (Dialogic)

1 Introduction

1.1 Background of the project

This study addresses the impact of ICT in the domain of health care. We focus on the direct effect of the availability of e-health infrastructure on the use of e-health, and in turn on the direct effects of the use of e-health on the outcome of a health system (effectiveness and efficiency of the system). The scope of the study is confined to advanced economies.

The objective of this study is to detect and analyze systematic relationships among aspects of availability, use, and effects that can be measured and for which broad-based data exist. Thus, we seek to go beyond isolated case studies and anecdotal reports, which may be important for illuminating the potential for ICT's impact, to see what impact actually has occurred.

This objective has significant requirements and limitations. The requirements are for up-to-date broad-based data on important items that may be very hard to measure, such as quality of care, patient satisfaction, and ease of obtaining care. Ideally, to measure efficiency, for example, we would able to distinguish prices and quantity of specific medical services. If our only available measure is total spending on health care (price multiplied by quantity), we cannot distinguish among a favourable outcome in which ICT allows prices go down and quantity to go up even more and an alternative result in which prices go up and quantity stays the same. An important limitation is that, unless we have data for, and engage in, a very complicated analysis with both time series and cross-section dimensions, it is possible that the systematic relationships we seek may be obscured by temporary inconveniences and transition costs that always arise when new technologies are adopted. Although these requirements and limitations are important and may affect our findings, we believe that the relationships that we do establish will stand on solid ground.

1.2 Use of ICT in health care: mixed results so far

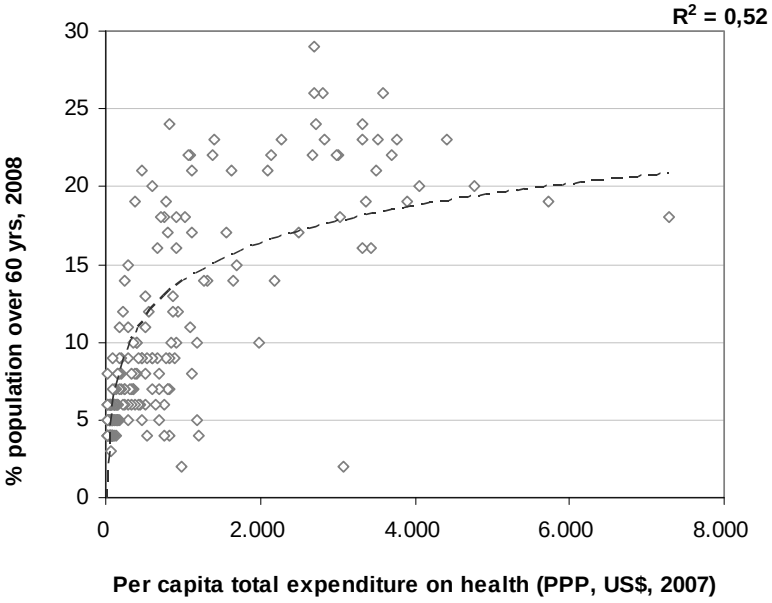
Compared to government and especially education, the use of ICT has a long tradition in health care. The first IT systems were used in the U.S. in the 1950s, primarily for the management of medical records (health care information systems) and for the support of diagnosis (expert systems or DSS). The vital nature of the quality of the medical systems led to the creation of a separate discipline for IT in health – medical informatics – which was established around 1970 (Patton and Gardner, 1999).

Currently, ICT is being used in nearly every stage of the health care process, from remote monitoring of patients and distance collaboration between specialists to the use medical imaging systems and electronic invoices for medical care. Likewise, health care informatics encompasses a broad set of services which include, besides the aforementioned health care information systems, services

like telemedicine (including virtual health care teams), electronic health records (EHR) and consumer health informatics.

Two of the most important societal trends driving developments in health care in general are the ageing of populations around the world and the continuous increase of chronic diseases such as cardiac and vascular diseases and diabetes (Anderson, 2007). The two trends are obviously related. Old age has its infirmities. Ageing alone is directly related to in increasing expenditure on health care.

Figure 1. Total per capita expenditure on health (PPP, US$, 2007) x percentage population over 60 years old (2008).[1]



Consequently, in countries across the world expenditures on health care grow faster than GDP. For instance, Armijo estimates that total expenditures on health care in Latin-America will double in the next twenty years (Armijo, 2008).[2] In response to the increasing financial burden, many developed countries have developed policies to bring about a shift from expensive inpatient care to outpatient care (Lewin Group, 2003). It is assumed that telemedicine (e.g., telemonitoring) plays a crucial role in this development (Armijo, op.cit.). In a similar vein, countries increasingly put more focus on preventive care. Here again, the deployment of e-health (e.g., targeting preventive care on specific population groups based in data-mining of electronic health records and statistics) could contribute greatly to the containment of further increases in health care expenses.

The most important technological trend for e-health has been the widespread use of the internet. Its effect has even been so great that term e-health (internet-

[1] Source: WHO (2010). World Health Statistics 2010, Geneva: WHO.
[2] More precisely, an increase from US$148 billion in 2000 to 359 billion in 2025.

based health care practices) has become more or less interchangeable with health care informatics (Wikipedia, 2010a).

It is useful to distinguish between two realms of ehealth – those information flows that occur solely among health care providers and payers and those that also involve patients. In the traditional health care information systems, we see a rapid increase of the use of networked systems, that is, the inter-organizational exchange of medical data. Key to this is the establishment of a *national* EHR (not a stand-alone version which has been around since at least the early 1980's). As for consumer health informatics, that service hardly existed before the rise of the internet. However the abundant supply of more or less reliable medical information on the internet, and easily accessible communication with fellow patients all around the world has greatly empowered patients in their relationships with doctors.

One Dutch study found that two-thirds of all people looked for medical information on the internet prior to a visit to their general practitioner and that one-third decided to visit their GP (or at least visit their GP sooner) because of the information they found (Ongena, 2008).[3] As for the visit itself, one-third of the people who looked for medical information on the internet perceived a change in treatment due to the information they discussed with their doctors. These are significant changes, implying a 22% increase in the number of visits to GPs and a similar 22% change in the initial treatment received.

The changing relationship between the doctor and the patient – which was traditionally rather hierarchical– is one of the reasons that the use of ICT is greeted with mixed feelings by the medical professionals. The information and communication possibilities of the internet not only apply to patients but also to doctors. This could directly and indirectly (via improved communications between medical professionals) lead to an improvement of the quality of health care (and thus an improvement of the health situation in country) since better informed medical professionals presumably make better diagnoses. Whether the application of ICT leads to an improvement in quality at all is, however, to a large extent dependent on the quality of the implementation, that is, *how* ICT is actually being deployed in practice. This is true in any domain but seems to be even more so in health care, due to the greater sociotechnical complexity. Koppel et al. (2005) and Silverstein (2009) even argue that ill-conceived applications that provide a mission-hostile experience to busy clinicians distract them and actually *in*crease chances for medical error. A similar picture emerges for the implementation of EHR, which is a critical component for networked health information systems (Linder et al., 2007). Based on an extensive meta-literature review, Greenhalgh et al. (2009) conclude that the secondary processes

[3] Similar trends have been observed across Europe. In 2009, one third of individuals aged 16 to 74 in the EU-27 had searched online for health information in the past 3 months, although there were wide variations across countries (from 10 % in Bulgaria to 56 % of the population in Finland). Results from other European surveys suggest that up to one-half of European adults may have ever searched online for health information (European Commission, 2010).

(research, audit, and billing) may be more efficient due to the use of EHR, but primary clinical processes may be made *less* efficient. They also found that smaller systems (e.g., EHR on a local or regional scale) may sometimes be more efficient than larger ones (e.g., EHR on a national scale).

The improvement of efficiency is actually the second and most often mentioned advantage of the use of ICT in health, after the improvement of quality of health care. The automation of patient administration, for instance, leads to a reduction in costs and would indirectly also improve the quality of health care since it frees time for primary clinical processes (e.g., actual interaction with patients) and other secondary processes (e.g., self-study by medical professionals, which is greatly facilitated by the internet anyway). In a broad case study project on the economic benefits of e-health, Stroetman et al. (2006) reported an *average decrease in unit costs of over 50%* of which 52% accrue to medical professionals and 43% to citizens. The wide disparity between the findings of the Greenhalgh and Stroetman studies might be attributed to the particular setting, that is, the precise manner in which ICT is deployed in a specific health care setting. Note that Stroetman refers to a limited number of selected "best practices" whereas the Greenhalgh study has a broader coverage of cases.[4] In other words, there is much potential for efficiency improvements due to the use of ICT, but these gains are not obtained easily.

Whether the presumed *efficiency* gains also lead to *quality* improvements remains to be seen. The results of a pan-European survey among GPs seem to suggest that the use of ICT does indeed give rise to efficiency gains but that these gains lead to perverse effects in terms of quality (see hereafter, Section 2). The use of ICT leads to more efficient scheduling (administrative systems) and to an increase in demand (patients looking for information on the internet – see Dutch study), and thus to an increase in the number of patients coming to a practice. Because of this, GPs feel that they have less time to treat their patients, that they have to limit the scope of services they can offer, and that the relationship with their patients becomes more impersonal (Meyer et al., 2009).

The same survey also found mixed results on the benefits of internet information for patients. In the latter study, people tend to perceive the quality of information on the internet as higher and the quality of the information given by their GP lower the more serious their sickness is. This stands in sharp contrast to the perspective of the GPs (EC survey) who think that internet information is quite beneficial to regular patients (however GP's rarely refer their patients to internet sites) but rarely or never helps the chronically-ill in self-management.

To sum up, the use of ICT in health care may increase the efficiency of secondary processes but the impact on primary processes is less clear. At the same time, the

[4] The results of the Stroetman study were based on ten carefully selected best practices which were in turn selected from 100 successful e-health implementations. Furthermore, the cost savings and distribution of benefits showed an extreme degree of variation, ranging from 1% to 99%. Finally, efficiency gains are not necessarily accompanied by cost savings in health budgets or society (OECD, 2005).

privileged position of medical professionals is under pressure from the increased empowerment of patients.

1.3 Conceptual framework

1.3.1 Conceptual framework

To describe the impact of ICT on health care, we use a general model for the measurement of the impact of ICT that we have previously used in the domain of eGovernment (Holland et al., 2004). The model distinguishes three subsequent stages of ICT deployment: *Readiness* (mostly referring to the supply side), *Use* (mostly referring to the demand side), and *Impact*.

Indicators for Readiness are readily available, albeit with a bias on hard ICT infrastructure. Only recently, more attention has (rightly) been paid to soft infrastructure such as ICT policy and skills. Older studies tended to link readiness to *potential* impact (see, for instance, UNPAD, 2005 and Kirkman, Osoria, and Sachs, 2001). However, readiness as such will not lead to impact (although the presence of ICT might directly improve the perception of citizens on the impact of ICT. *Use* obviously is the linking pin between readiness and impact. In this study, therefore, particular attention is being paid to the *use* of e-health (see especially section 2).

Figure 2. General conceptual model

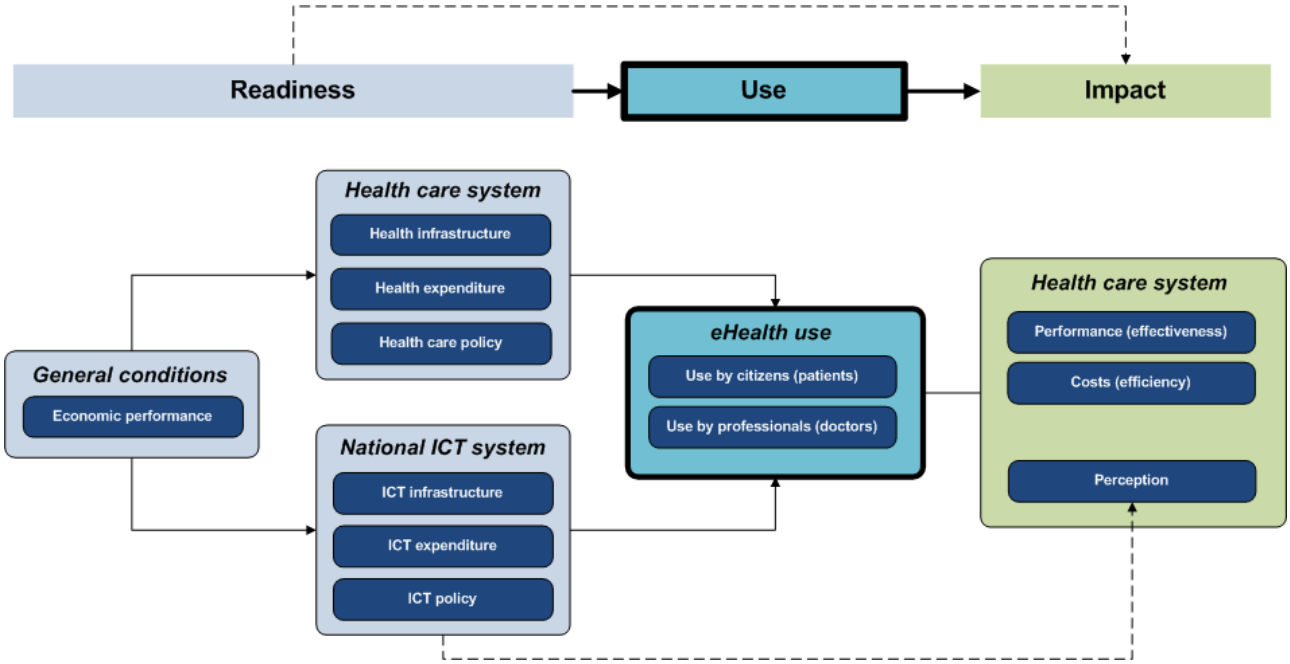
In the next paragraph we will further elaborate the general model to e-health.

1.3.2 Conceptual model applied to e-health

Starting from the centerpiece of the general conceptual model, *Use*, we have already seen in the introduction on e-health that the developments for patients and professionals are markedly different. This means that we should distinguish at least use by citizens (patients) and use by professionals (doctors). In a similar vein, with regard to *Impact*, we should at least distinguish between effectiveness (changes in the *quality* of the health care; the health conditions of citizens) and *efficiency* (changes in the costs of providing health care). Furthermore, to see whether the direct link between Readiness and Use that we found for eGovernment also holds for e-health, we should also include the *perception* of citizens, both on the performance of the health care system as such (macro level) and on their own health situation (micro level).

With regard to Readiness, there are at least two relevant building blocks: the *general situation of the health care system* per se (thus without the e-component) and the *general ICT situation in a country*. In turn, both blocks can be divided into infrastructure, expenditure and policy. The expenditure on health and ICT, and thus the development of the two blocks, are finally driven by the general economic situation of a country. We then arrive at the following figure:

Figure 3. General conceptual model applied to e-health



In section 3, for each of the 12 variables in this model one or more indicators will be developed.

1.4 Research approach and overview of the report

There is ample international comparative quantitative data for both the Readiness and Impact indicators (at least when it comes to indicators for the health condition of a population). Use is much less well covered in international sources (that is, WHO, OECD, UN, etc.) Luckily the European Commission has recently commissioned two broad studies on, respectively, the use and the economic impact of e-health. These studies cover all 27 member states plus Norway and Iceland. This is obviously not world-wide coverage but it does cover a sizeable set of quite different countries, ranging from small and big to developing and advanced economies.

To make the maximum of these two comprehensive studies, and given the pivotal role of Use, we have devoted an entire section (2) to review the results of the studies. Section 2 gives a somewhat more qualitative and in-depth edge to the purely quantitative model that is being develop in section 3. Much of the data on the Use indicators in the model is being derived from one of the two studies that are discussed in section 2. The Use data is complemented with Readiness and Impact data from various other international sources. The source data from section 3 is also (re)used in the charts in the country studies in section 4. These figures give structure to the three country studies to enable the mutual comparison. Based on preliminary desk research, three countries were selected: Denmark (one of the leading countries in Europe in e-health as it appeared from section 2), Spain (an average performer in e-health but with significant improvements lately), and Canada (one of the early

pioneers in telemedicine and one of the leading countries outside Europe). The findings from section 2 and 3, complemented with desk study on each individual country, are used to interpret the data in the figures. In the concluding section 5, the findings from the three preceding sections are integrated into overall conclusions.

2 Use and Impact of e-health in Europe

2.1 Readiness and Use

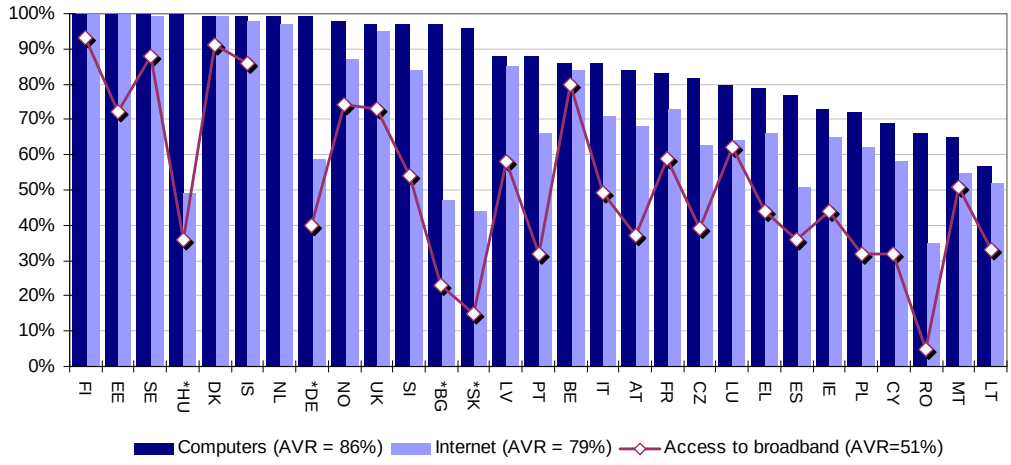
In 2002 and 2007 the European Commission (DG Information Society) commissioned two broad surveys among 6,800 general practitioners in all 27 member states plus Iceland and Norway (Meyer et al., 2009). The studies mapped the way GPs used ICT and the internet to communicate with their patients and with primary and secondary care and other health actors (such as insurance companies and health authorities).

The results of the study give a detailed insight into the current situation and recent developments with regard to Readiness and Use of e-health.

2.1.1 Readiness

The presence of computers in GP practices and internet connections has grown rapidly over the last five years, from 81% to 90% (computers) and 63% to 73% (internet). In a number of countries, complete saturation has been reached. There is a moderate correlation between the presence of computers and internet connections although not as strong as expected.[5] Broadband access – which is considered essential for the transmission of visual data or streaming associated with monitoring – closely follows the pattern of internet connection.[6]

Figure 4. Presence of computers, internet connections, and broadband access in European GP practices, 2007



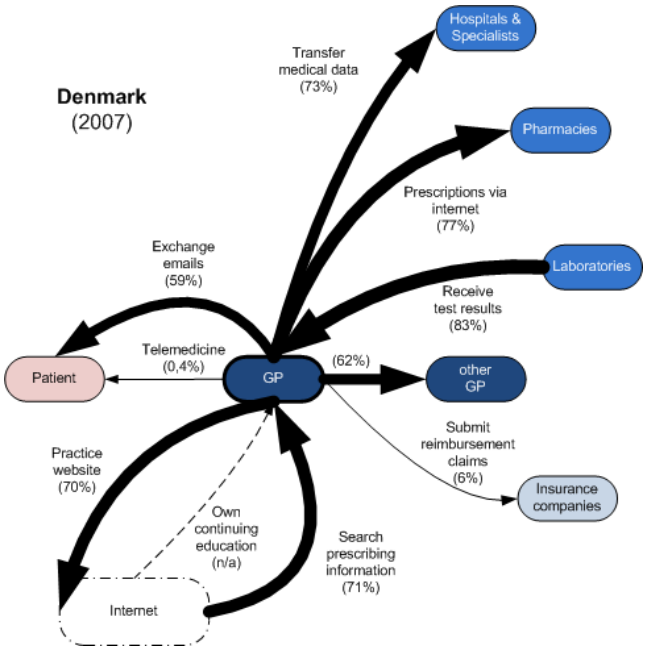
[5] R^2 = 0,25. This is entirely due to low internet connections in a number of eastern European states (Bulgaria, Hungary, Slovakia) and – surprisingly – Germany. Without these states (marked with an asteriks in Figure 4), r^2 rises to 0,85.

[6] R^2 = 0,84.

2.1.2 Use

In line with the trend in Readiness, the Use of e-health applications has also grown rapidly across the board. In Denmark, which leads the pack in Europe, almost all types of data exchange are in the 60%-70% saturation range.[7]

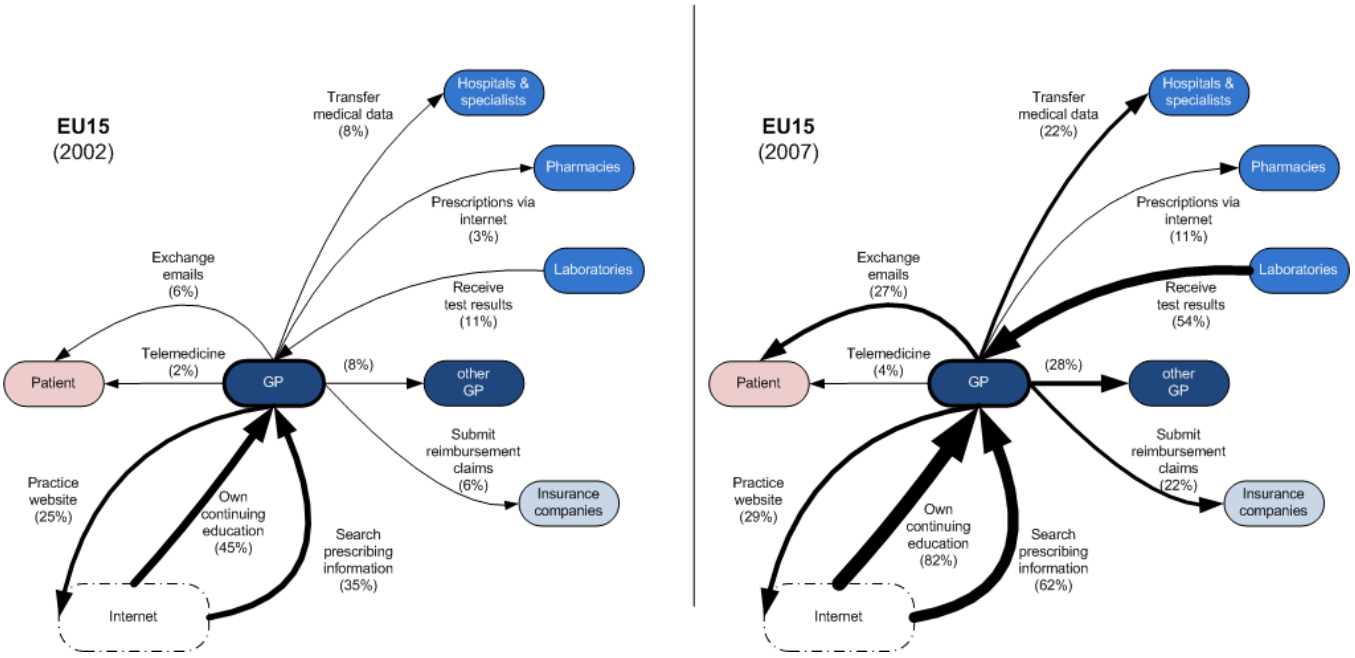
Figure 5. Diffusion pattern for various type of e-health use, Denmark, 2007



There are, however, some marked differences between the various types of use. Despite the assumed pivotal role of telemedicine in the containment of the ever-increasing health care costs, the use of telemedicine has hardly grown at all in Europe. The only exception is Sweden but the extensive country still has a meagre 9% diffusion rate. The percentage of practices with a website was relatively high in 2002 but has hardly grown since. On the contrary, the use of internet by GPs for their own purposes (search for medical information and self-education) was already relatively high in 2002 but has continued to grow at a high pace.

[7] An exception is the use of telemedicine – see hereafter (which might be partly due to the fact that Denmark is a very small country and density of GP's and hospitals is very high – see section 4) and the electronic submission of reimbursement claims to insurance companies. The latter is entirely due to the particular institutional set-up of health care in Denmark. Nearly all health care is provided free of charge and involves no claims to a insurance company. GP's are funded on block grants from the government.

Figure 6. Diffusion pattern for various type of e-health use, EU15, 2002-2007



The averages in the figure mask the fact that there are still large differences between the countries – much larger than in Readiness. There is a clear leading group consisting of all Scandinavian countries (including Iceland), the Netherlands and the United Kingdom.

Table 1. Readiness and Use of e-health, top 7 versus rest of EU27

Readiness	*Top 7*	*rest*
Computers in practice	99%	83%
Computers in consultation room	93%	70%
Internet connection	96%	64%
Use	*Top 7*	*rest*
STAND ALONE		
Using Decision Support Systems (DSSS) for diagnosis	88%	46%
Using Decision Support Systems (DSSS) for prescribing	62%	24%
Using Decision Support Systems (DSSS) for general advice	57%	29%
Using Decision Support Systems (DSSS) for patient specific advice	32%	13%
ONLINE COMMUNICATION WITH PATIENT		
Email medical data to patients	51%	3%
Practice website	68%	23%
ELECTRONIC EXCHANGE OF PATIENT DATA		
Prescriptions to pharmacies	62%	24%
Receiving lab results from laboratories	83%	21%
Sending administrative data to reimbursers	25%	8%
Sending medical data to other care providers	35%	4%
Prescriptions to pharmacies	39%	1%

Table 1 strongly suggests that Readiness precedes Use, and that the lagging countries will reach similar levels of Use in due time. There are, however, marked differences between the various types of Use. In general, stand- alone usages are strongly correlated with Readiness and internet usage is moderately strong. Online communication with patients and the electronic exchange of patient data with other health actors is only weakly correlated with Readiness, with the exception of receiving test results from laboratories. All variables strongly to moderately strongly correlate with the e-health maturity of a country, with the exception of sending administrative data to reimbursers.[8] The contrasting correlations in the last category of use, electronic exchange of patient data, can be explained by the fact that sending lab results (0,78) and medical data to other care providers (0,69) requires much more prior investments (e.g., in a fully secure intranet and in EHR's with a national coverage) than the other two types of use.

Table 2. Correlation between Readiness and Use, for various type of Use, EU27+2, 2007

Readiness	*Use*	*Correlation with Readiness (R^2)*	*Correlation with Maturity (R^2)*
	STAND ALONE		
Computers in practice	Electronic storage of individual patient data	0,78	0,65
Computers in consultation room	Use of computers during consultation	0,93[a]	0,68
Computers in consultation room	Use of DSS for diagnosis	0,81	0,71
	INTERNET		
Internet in practice	Search for medical information	0,52	0,58
	ONLINE COMMUNICATION WITH PATIENT		
Internet in practice	Email medical data to patients	0,23[b]	0,45
Internet in practice	Practice website	0,38[c]	0,42
	ELECTRONIC EXCHANGE OF PATIENT DATA		
Internet in practice	Receiving lab results from laboratories	0,53	0,78
Internet in practice	Sending administrative data to reimbursers	0,16	0,31
Internet in practice	Sending medical data to other care providers	0,34	0,69
Internet in practice	Prescriptions to pharmacies	0,16[d]	0,14[e]

a without outlier Slovenia. Including Slovenia: 0,88
b without outlier Denmark Including Denmark: 0,15
c without outliers Finland and Iceland. Including these two countries: 0,46
d without outliers Denmark, Sweden and the Netherlands. Including these three countries: 0,26
e without outliers Denmark, Sweden and the Netherlands. Including these three countries: 0,47

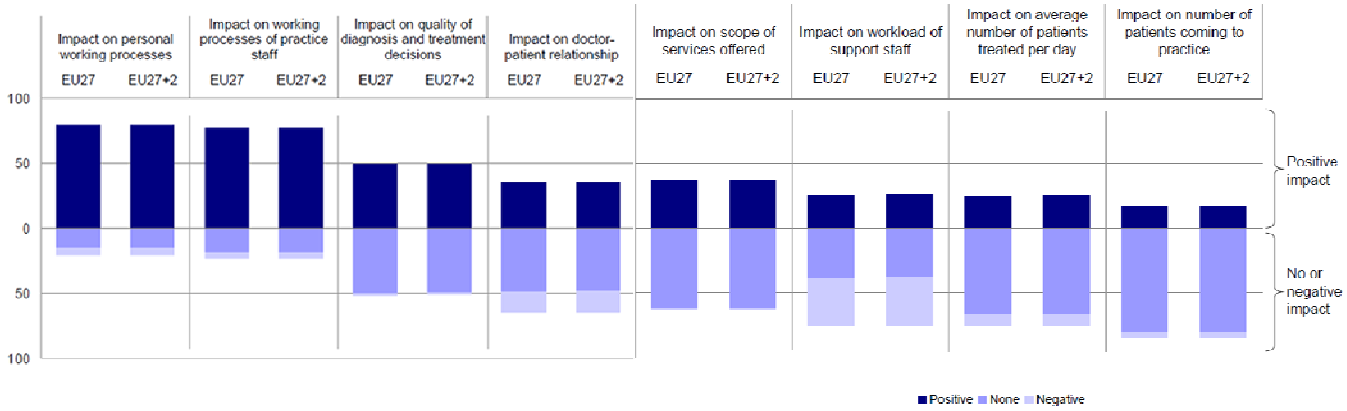
[8] The correlation for Prescriptions to pharmacies increases to 0,47 if we add the three outliers Denmark, Sweden and the Netherlands, which are all part of the top 7.

2.1.3 Perceptions on the impact of using e-health

One of the most striking results of the 2007 survey is that there is no relation whatsoever between the intensity of use and the perception on the impact of e-health. Although all countries are rather strongly positive about the impact of e-health – they generally think that ICT improves the quality of health care services [GPPERQAL] – there are no correlations with the level of e-health maturity [EHEALTX] and also no difference between the top seven and the rest of the countries.[9]

If we zoom in on the underlying motivations, it becomes clear that the judgement of the GPs is much less positive, and actually quite negative about the impact on quality. Overall, GP's think that the direct impact of ICT on quality in terms of diagnosis is neutral. ICT has a positive influence on *efficiency* but this causes an increase in the workload and the number of patients treated per day. This in turn leads to a deterioration of the scope of services offered and of the doctor-patient relationship. In other words, the indirect effects of the efficiency improvement on quality are negative, and exceed the neutral direct effects on quality improvement.

Figure 7. Perception of GP's of e-health impacts, EU27+2, 2007



This is, of course, purely the view from the GPs' side. Their negative perception of ICT-induced quality improvements might at least be partly due to the fact that they regard ICT as a threat to their own position and/or the quality of their own work. An increased workload might not necessarily affect the quality perception of patients in a negative way.

Ideally, quality of healthcare would be measured using objective data, such as length of waiting times, or in direct data, such as patients' satisfaction. Accenture has recently done a survey in a number of countries which cover some of these measures (Accenture, 2010). Alas the overlap with the countries in the EU 2007 survey is very limited: only seven countries appear in both surveys.[10]

[9] The average score for the entire group of 29 countries was 1,40 (on a scale from +2 [agree strongly] to -2 [disagree strongly]. Average score for top 7 was 1,43; for the rest 1,38.

[10] France, Germany, Ireland, Italy, Norway, Spain, and the United Kingdom.

We looked at four quality items from the Accenture survey: the policy priority attributed by citizens to respectively reducing waiting times [REDUWAIT], setting higher quality standards for all health care providers [INCRQUAL], increasing the number of medical professionals [INCRNUGP], and the average rating of the quality of health care in a country [RATEOVRL]. Again, we found no correlation whatsoever between the e-health maturity index [EHEALTHX] and any of the quality indicators. The same goes for the perception that ICT improves the quality of health care [GPPERQUAL], with one notable exception: the urge to reduce waiting times [REDUWAIT]. This suggests that the perception of citizens is opposed to GPs: they think use of ICT will reduce waiting times and thus increase overall quality of health care. Hence from the perspective of the patients, efficiency is not diametrically opposed to quality.

Table 3. Correlations between e-health maturity and various quality measures (N=7)

	GPPERQAL	INCRNUGP	REDUWAIT	INCRQUAL	RATEOVRL
EHEALTH	0.235	-0.045	-0.340	-0.120	0.593
GPPERQAL		0.222	0.787*	0.424	-0.177
INCRNUGP			0.363	0.205	0.363
REDUWAIT				0.389	-0.470
INCRQUAL					-0.322

* Correlation is significant at 0.05 level (2-tailed)

3 Macro model

3.1 Building the model

3.1.1 Introduction

In the previous section we have found a clear relationship between Readiness and Use. The relationship between Use and Impact is more ambiguous. The most prevalent impact seems to be efficiency gains; impact on quality is at best neutral. One of the possible reasons has already been mentioned in the introduction: it is not a matter of using ICT per se, but *how* ICT is being deployed. This old truth again strongly comes out in the survey of best practices in economic impact of e-health (Stroetman et al., 2006). One of the most important determinants for success is the presence of a clear vision of long-term goals and a focus on concrete, well-defined needs. This might not only hold on the micro level of projects but also on the macro level of countries.

Alas the efficiency gains indirectly have a negative effect on GPs' perception of quality (although perhaps not actual quality), since they feel that the relationship with their clients deteriorates. That relationship is already fundamentally changing due to the pervasive use of the internet. But it is not only the patients that are using the internet to look for medical information. It is also the kind of use that has seen the highest growth rates across all European countries.

In this section we test most of the hypotheses that are postulated above.

3.1.2 Data collection

Quantitative data was collected from the following cross-national data sources (see appendix 1 for a comprehensive overview):

For economic statistics

- OECD (2009)
- EuroStat (2009)

For ICT statistics

- ITU (2009)

For health statistics

- World Health Organization (2005) Global e-health Survey
- EC, Eurobarometer (2007)
- Empirica, European Commission (2007) Benchmarking ICT use among General Practitioners in Europe
- Survey Patient View for the Euro Health Consumer Index (2009)

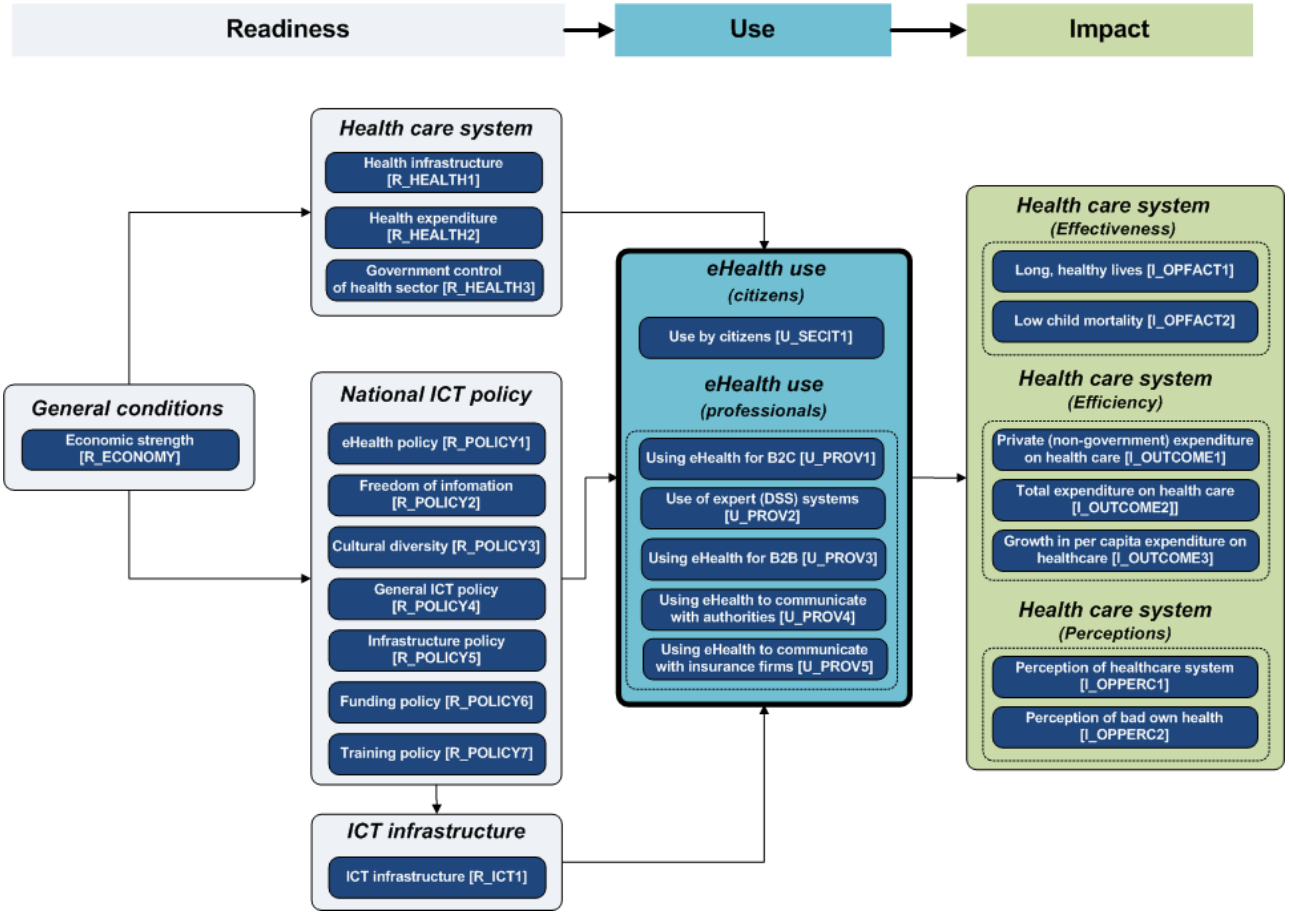
3.1.3 Approach

We have first calculated Pearson R (zero-order) correlations between all individual variables. Economic strength (GNI per capita) turned out to have a

pervasive impact throughout the model. We have thus decided to isolate that particular variable and use it as a control variable instead.

In order to reduce the enormous number of possible combinations we have used a principal components factor analysis to collapse the original 125 variables into 24 composite variables (components), while keeping GNI per capita apart as a control variable (see appendix II). The resulting components coincided nearly perfectly with the distinctions that had been made in the conceptual model (see figure below). All components consisted of combinations of variables that logically made sense. The components could thus be given labels that also empirically made sense (e.g., 'Use of e-health by citizens', 'Efficiency of the health care system' etc.). The factor scores were saved as residuals.

Figure 8. Components of the correlation model



A number of variables (all belonging to ICT policy variables, e.g., "does your country have policy X"?) were dichotomous (see Appendix II). Since factor analysis cannot be applied to such dichotomous (binary) data we have instead merged the data into one variable while testing for internal consistency.[11] Variables that did not make the threshold level were dropped.

Finally, we calculated the Pearson R correlations again but now between the components while controlling for economic strength (partial correlations), see appendix III. In this way, we could avoid spurious relations (that is, component A seems to be related to component B but this is entirely due to the fact that both are linked to a common variable – economic strength).

3.2 Results

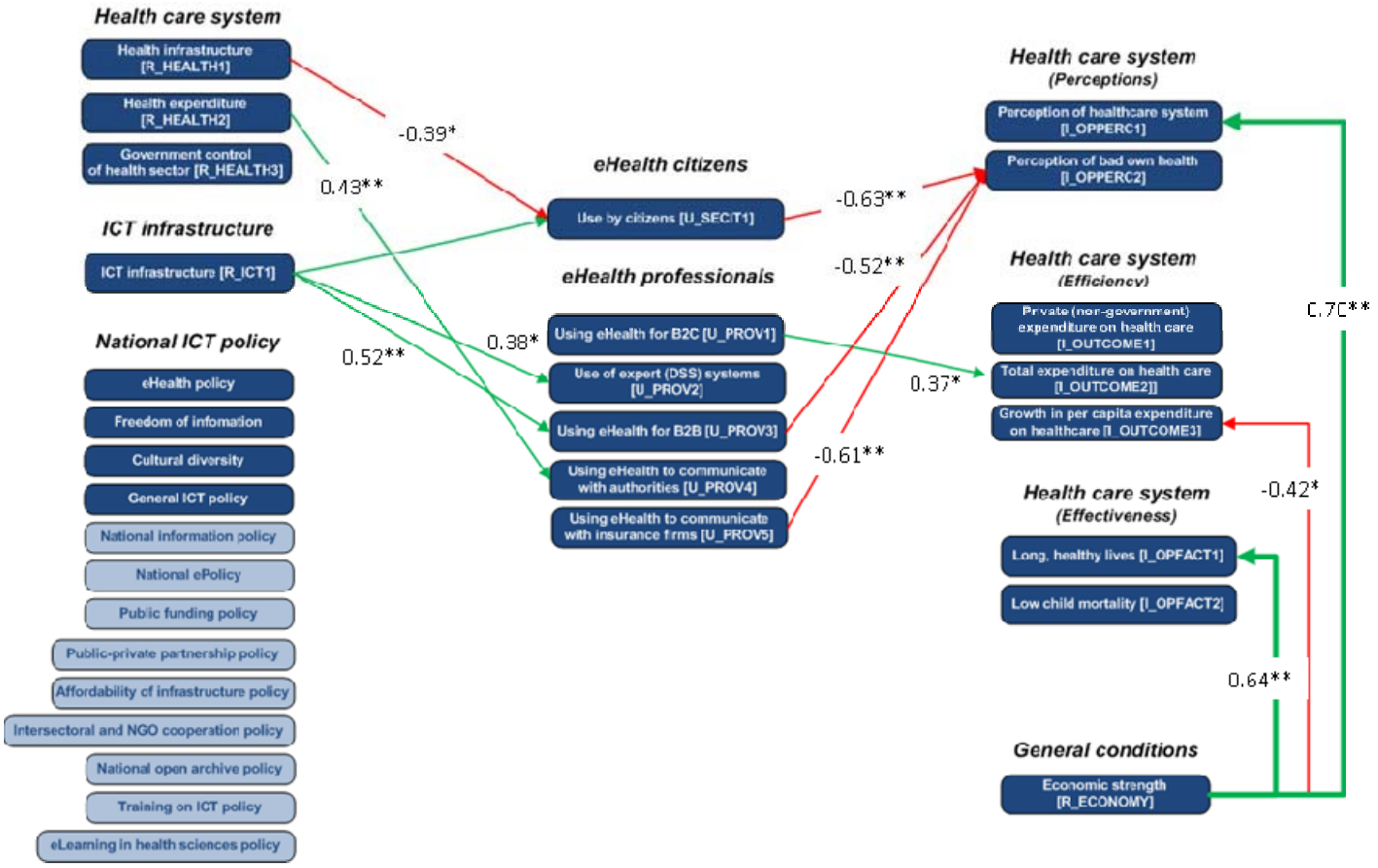
For each of the seven impact components we have calculated the correlations between Use and Readiness components. We have tested both the *indirect* relationships between Readiness and Impact (via Use, that is Readiness → Use → Impact) and the *direct* relationships between Readiness and Impact (that is, Readiness → Impact). The results of the tests are shown in the following two figures.

In the figures, each connecting line represents a significant relation.[12] Where no lines are shown, no significant relationship was found. The numeric value above the line represents the correlation coefficient r, which is a proxy for the strength of the relationship. Positive relations are indicated by a green font, negative relations by a red font.

[11] Using Cronbach's alpha with a threshold level of $\alpha > 0.70$

[12] The exact significance level is indicated by an asterisk, where * means a level of <0,05 (that is, a 95% chance that the relationship actually occurs) and ** a level of <0,01 (a 99% chance that the relationship actually occurs).

Figure 9. Significant indirect relations between Readiness and Impact (Readiness → Use → Impact)



3.2.1 Readiness → Use

The ICT infrastructure [R_ICT1] is positively correlated with various Use components, for instance with the use of e-health by citizens [U_SECIT1]. This just means that in countries with a more developed ICT infrastructure people are also more avid users of ICT, including e-health. The link with use of DSS [U_PROV2] and B2B [U_PROV3] signifies that the latter two types of use of e-health by professionals are the most advanced, or mature, and require the most extensive investments in ICT infrastructure (see table 2).

The positive correlation between (public) expenditure on health [R_HEALTH2] and using e-health to communicate with authorities [U_PROV4] is a logical one: the more money a government puts into the health care system the keener it will be to follow the money (auditing, etc.). Hence overhead increases and communication with authorities intensifies.

The *negative* correlation between health infrastructure [R_HEALTH1] and use of e-health by citizens [U_SECIT1] is an interesting finding. It suggests that, at least at this moment, the use of e-health is (partly) a substitute for the use of regular health care.

Note that the causal direction is unknown and the relationship might work both ways. Thus, it could be that the more doctors and specialists there are available the *less* need there is for a citizen to resort to e-health, or, the other way around, countries with a less developed health system have chosen to modernize their infrastructure via e-health.

3.2.2 Use → Impact

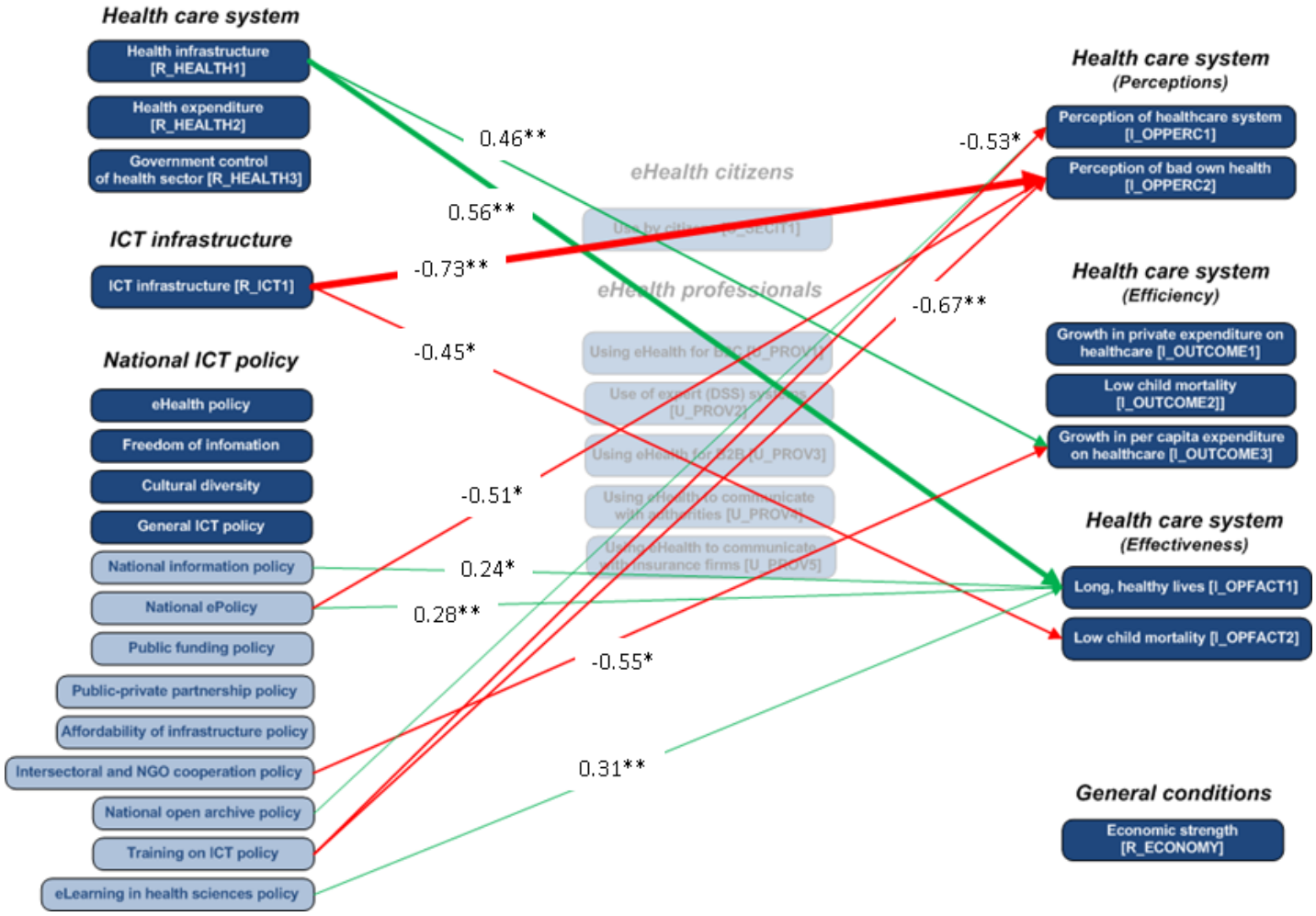
Economic strength [R_ECONOMY] still has the greatest impact on the outcome of health care systems than any of the other components. This simply means that the contribution of ICT to the outcome is (still) relatively modest. For instance, life expectancy is directly related to the welfare in a country. Similarly, inhabitants from richer countries tend to think that the health care system in their country performs relatively well. The *negative* relation with growth in per capita expenditure is due to the fact that it is easier to grow for countries with lower initial expenditure levels than for countries which already have high expenditure levels (a.k.a. 'dialectics of lead').

The impact component that stands out most is the perception of bad own health [I_OPPERC2]. With the exception of relatively growth of healthcare expenditure [I_OUTCOME2] this is the only impact component that is directly linked to one or more Use components. The fact that it is *negatively* related to the use of ICT is entirely explained by self-selection: the most avid users of medical information on the internet are also most concerned about their own health. Interestingly, this group also questions the quality of the diagnosis and treatment of GPs the most. Not surprisingly, then, we find that GPs think the use of internet rarely or never helps this particular group of chronically-ill people. It is here that we find the most succinct example of the changing relationship between doctors and patients.

In a similar vein, the use of e-health for B2B [U_PROV3] and communication with insurance companies [U_PROV5] can be explained by self-selection. Data from chronically-ill people is much more frequently exchanged than data from regular patients. The substitution of electronic workflows for traditional paper-based workflows might save both the GP and the patient a lot of paperwork.

The last remaining correlation, the use of e-health for B2C [U_PROV1] x growth in expenditure on healthcare related to GDP [I_OUTCOME2], is perhaps the most relevant one. B2C use covers nearly all types of use, except stand-alone uses (such as the use of Decision Support Systems). Quite frankly, it simply says that the use of e-health *increases* rather than decreases the expenditure on health care. Thus the presumed efficiency gains do not occur, or at least not at the macro level and not in the short run.

Figure 10. Significant direct relations between Readiness and Impact (Readiness → Impact)



3.2.3 Readiness → Impact

The number of *direct* links between Readiness and Impact surpasses the number of indirect links. This downplays the presumed pivotal role of Use.

Some of these links are rather obvious. Health infrastructure [R_HEALTH1] correlates positively with long, healthy lives [I_OPFACT1]. Thus investments in health infrastructure do pay off but naturally come at a price: they also increase the per capita expenditure on health care [I_OUTCOME3]. The performance of a health care system (in terms of long, healthy lives) is further improved by the implementation of national information policies [R_POLICY5] and eStrategy policies [R_POLICY6]. Hence

the importance of having a clear strategic vision seems to apply to the national level.[13]

Similarly, eLearning in health science policies [R_POLICY13] also correlates positively with long healthy lives. Thus is does pay off to invest in ICT-supported continuous training of doctors. Not surprisingly, then, the use of ICT for self-education is one of the fastest growing uses of e-health among GPs across all European countries. Another relevant finding is that intersectoral and non-governmental cooperation policy [R_POLICY10] leads to a reduction in the public expenditure on health care [I_OUTCOME3]. This is in sharp contrast to the use of ICT that we previously found. In other words, when a government wants to reduce expenditure on health care it should invest in streamlining intersectoral processes rather than in ICT.

Much more surprisingly is the positive (albeit weak) correlation between having a national archive policy [R_POLICY11] and long, healthy lives. The only (far-fetched) explanation is in democratic countries citizens feel less suppressed and that this has direct positive effects on their health. But note that [R_POLICY11] is not correlated to the perception of one's own health [I_OPPERC2].

In contrast to the health components, the significant relationships that were found for the ICT components are much harder to interpret. First, there is a very strong direct relationship between ICT infrastructure [R_ICT1] (and to a lesser extent between training on ICT policy, [R_POLICY12]) and the perception of one's own health [I_OPPERC2]. That is, the better the ICT infrastructure in a country (and the more training on ICT policy is given) the more positively citizens in that country tend to think about their own health. On the other hand, R_ICT1 is *negatively* related with improvements in the infant mortality [I_OPFACT2] and R_POLICY12 with the perception of the healthcare system [I_OPPERC1]. There is no apparent explanation for the very existence of these relationships, neither for the direction of the relationships. The relationships are, however, relatively strong and are also supported by some anecdotal empirical evidence. For instance, in Section 2 we have seen that Denmark is the undisputed frontrunner in both Readiness and Use of e-health (Section 2) but we will see that it is also the country with the worst medical performance in Europe during the last decade (Section 4). Again, this nuances the present contribution of the use of ICT to the quality of health care.

[13] Note however that [R_POLICY6] has a negative relationship with the perception of the health care system [I_OPPERC1]. Thus although it actually helps to improve the performance of the health care system, people tend to *think* it only hampers the functioning of the system.

4 Country studies

4.1 Introduction

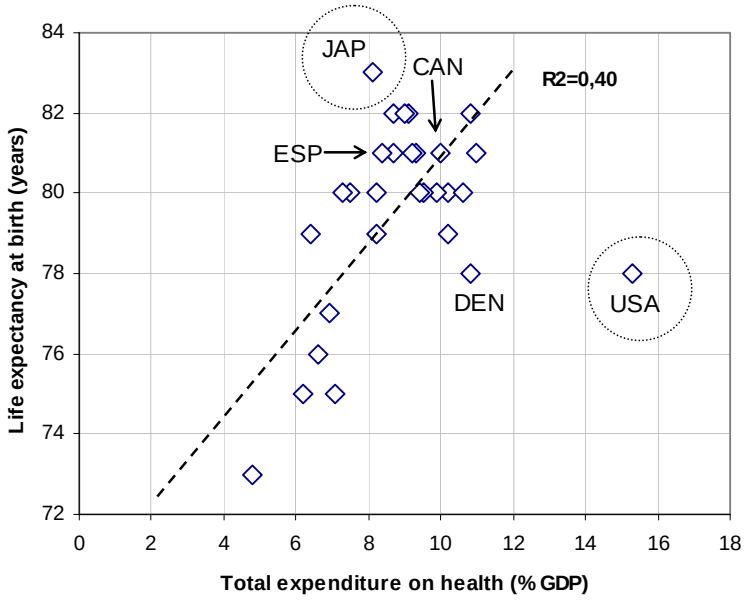
4.1.1 Global comparison health performance reference countries

To provide a better understanding of the implications of the model, a case study was performed among three countries: Denmark, Spain, and Canada. These countries are compared with respect to readiness, use and impact of ICT on healthcare.

One of the key drivers for both ICT use and impact on healthcare was the economic strength of a country (measured in terms of gross domestic product per capita). In the evaluation of the results of the country studies, this factor should also be kept in mind. GDP per capita for Canada (US$ 38.500) and Denmark (US$35.951) are quite similar but GDP for Spain (US$31.586) is somewhat lower.[14]

Another factor that has a major influence on the impact of the health care system (in terms of life expectancy at birth) is the expenditure on health. From Figure 11 it can be seen that the two factors are indeed fairly strongly correlated (r^2 = 0.40). Notable exceptions are the United States and Japan. With respect to the reference countries, Spain is doing well with a high life expectancy compared to expenditures, Canada is exactly on the regression line and Denmark's life expectancy is somewhat below what is to be expected from its total expenditures on health.

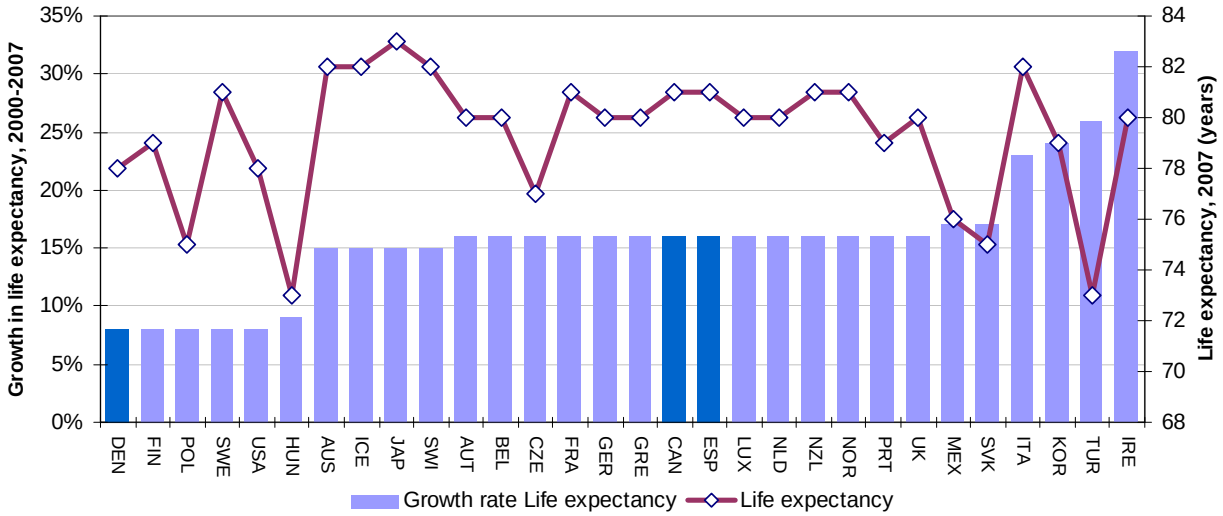
Figure 11. Expenditure on health x life expectancy at birth



[14] Source: OECD Factbook 2009. GDP is US$, current prices and PPPs, 2007.

Use of e-health has rapidly risen since the end of the 1990's. Thus we might cautiously assume that changes in the outcome of the health care system since 2000 have been influenced by the level of e-health use in a particular country. Now, Canada and Spain are doing fairly well but Denmark – our presumed frontrunner – has the *lowest* score (although it has a similar starting value as Canada and Spain).

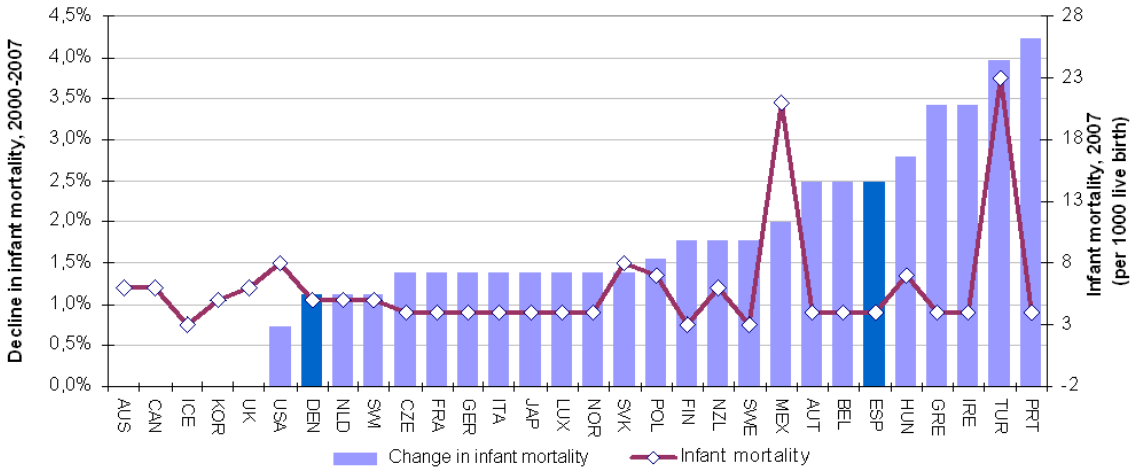
Figure 12. Life expectancy in OECD countries,2007, and compound annual growth rate, 2000-2007



To test the relationship we have also plotted another widely used indicator for the performance of health care, namely infant mortality under 5 years.[15] Again, Spain is doing fairly well, Denmark is again at the tail and Canada has not experienced any decrease at all. Note that the starting values for the three countries are the same (thus the high score of Spain cannot be explained away by an initial high mortality rate).

[15] Note that we have inverted the growth rate. In all countries the mortality rate is actually *de*creasing.

Figure 13. Infant mortality in OECD countries, 2007, and compound annual growth rate, 2000-2007

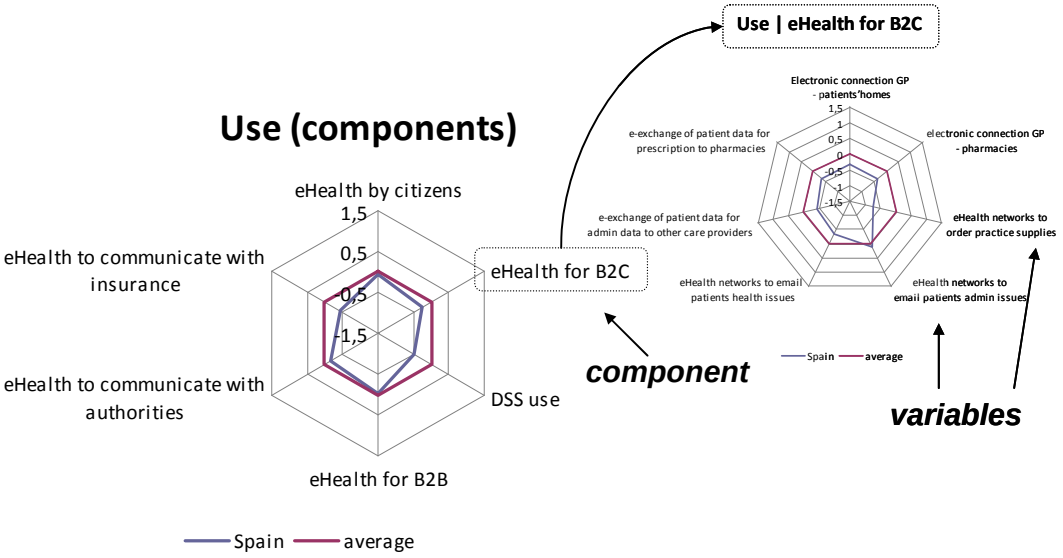


The data about infant mortality rate and life expectancy show that the healthcare situation in Spain is favorable; the life expectancy is relatively high and infant mortality low. In addition, in recent years the infant mortality has decreased even further. The situation is less favourable in Denmark. Infant mortality rate is strong, but life expectancy is low for a western country, and in comparison with OECD countries the increase in life expectancy is even lower. The situation in Canada with respect to life expectancy is average for the OECD.

4.1.2 Explanation of radar charts

In the country studies, two types of data are used for the radar charts: data that provide information about individual variables and data that provide information about components. The variables are detailed scores that link to particular aspects covered in the case. The components are aggregated individual variables and are created by the factor analysis as described in section 3. They provide general information about the readiness, use and impact of ICT on health care in the related countries.

Figure 14. Explanation of radar charts



The radar charts are created from data about the OECD countries. However, not every variable or factor information about all countries was available. Appendix IV shows a list of the countries that contribute to the average and appendix V shows information about the variables used in the radar charts.

This format refers to Spain and Denmark. Because we have less comparable data for Canada the format for that country differs from the other two countries.

4.2 4.2 Canada

4.2.1 Context

Population in Canada is extremely unevenly distributed. Population density is very low (119 mile^2 for every person, against 4.5 mile^2 for Spain and 3 mile^2 for Denmark). Since the majority of the people (80%) live in urban areas in the south the actual population density in the northern provinces is much lower than the aforementioned 119 mile^2. This makes Canada a logical place for the use of telemedicine. Quebec, for instance, started implementing telehealth services since 1989 in order to reach all its residents (ICTC, 2009). This includes isolated regions such as Nunavik. In Ontario, the Telemedicine Network covers 500 sites across the province. Alberta has its Netcare portal, which is somewhat akin to the national Danish system and which connects GP practices, diagnostic laboratories and pharmacies.

These initiatives have developed in an environment where most of the funds are provided by a single payer, the public insurance company. The public funds account for 70% of the Canadian healthcare expenses. The other 30% originate from private funds. Typical purposes for public healthcare funds are hospital and GP visits.[16]

[16] Dentists and ophthalmology visits are funded by private initiatives.

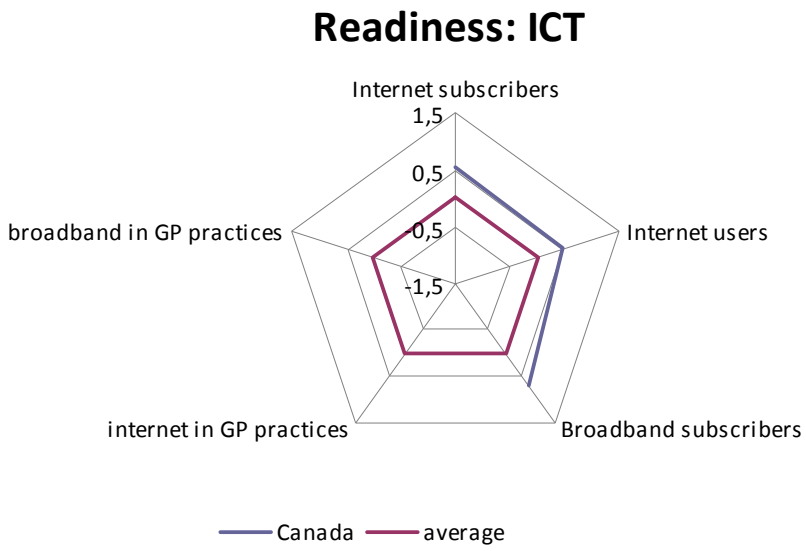
For Canadians basic care is provided through public funds and is free.Patients are not involved in billing and reimbursements. Regulated by law, healthcare providers are not allowed to bill the patients; they are forced to arrange the expenses directly with the insurance company. As a consequence, the medical administration is rather simple. An additional benefit for the ease of administration is the lack of participation in day-to-day care or collection of any information about an individual's health, even though the purpose of this policy is to guarantee confidentiality between patient and physician. These measures yield a relatively cost efficient medicare system.

The health care system is guided by a national Health Act but provinces are the key administrators in the system. E-health is also run provincially, which has resulted in the creation of different incompatible systems (Wikipedia, 2010b). There is also no national EHR yet. The introduction of a uniform EHR has been delayed for years and it still not implemented in, for instance, Ontario. As in many other countries, privacy concerns have greatly hampered the swift implementation of a national EHR. The recent hack of the Alberta's Netcare system, which compromised the privacy of over ten thousand patients, shows that these concerns are quite reasonable (OIPC, 2009).

4.2.2 4.2.2 Readiness

For a country that has strong ambitions to benefit from telemedicine, ICT readiness is of utmost importance. And Readiness *is* very high in Canada, although not as high as in Denmark. Alas, we have no figures on the specific use of ICT in health.

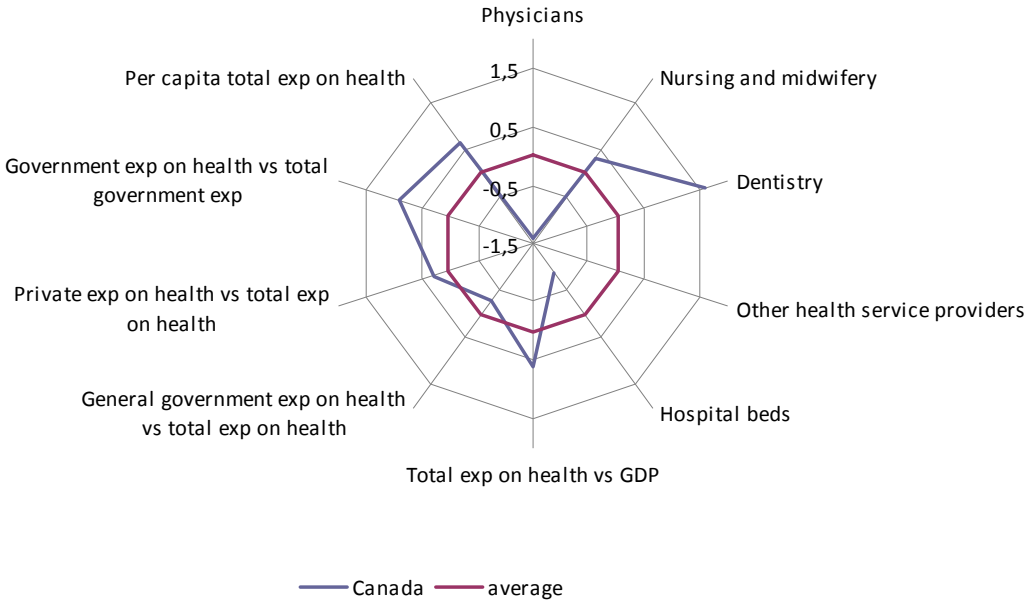
Figure 15. ICT Readiness in Canada



The other component on Readiness is the quality of the health care system. Canada scores well across the board, with the remarkable exception of the low

number of physicians.[17] This means that each GP has to cover an enormous area which is another strong incentive for the deployment of telemedicine. Next to the lack of GPs, there is also a severe shortage of hospital beds. In the period 1994-2004 capacity fell 40% (Eggertson, 2004). The lack of publicly-funded GPs and hospital beds becomes all the more painful in contrast with privately-funded dentists. The number of dentists in Canada is far above the OECD average. The declining quality of public health care has not been accompanied by cost savings. Public expenditure on health care is still significantly above average in Canada.

Figure 16. Health care Readiness in Canada



In summary, given the low density of GPs, the cost pressure on the health care system and the high availability of ICT-infrastructure there seems to be ample space for the deployment of telemedicine in Canada. The question now is whether and to what extent e-health is already being used in Canada

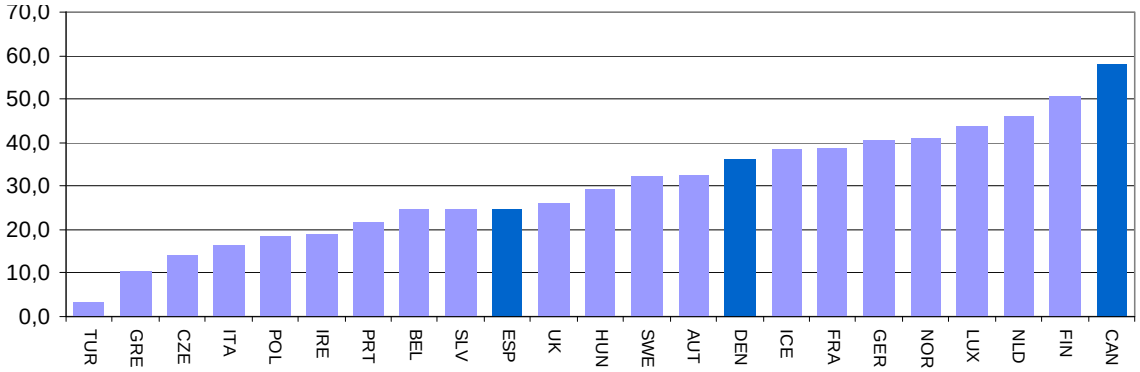
4.2.3 Use

On the citizen side, the potential for distance health care is certainly realized. Canada has by far the greatest percentage of citizens who use the internet to seek health information. As mentioned earlier, the ready availability of health information has a profound impact on the relationship between patients and GP's. The observations made there are underlined by a U.S. study on cybercitizens and health (Manhattan research, 2007). Health care consumers are becoming increasingly empowered – in many cases they challenge their physicians. These

[17] This situation has not always been the case. In the past, Canada was one of the leading countries with respect to the total number of physicians. Since the 90s, Canada decided to decrease medical school enrollment, the net migration of physicians to the U.S. increased and so, too, did the number of physicians who retire (Barer and Webber, 1999). As a consequence, Canada now suffers from a lack of physicians (CanWest, 2007).

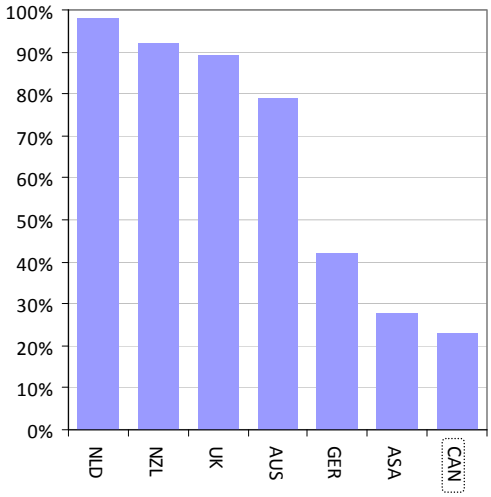
consumers have become increasingly confident about the health information they find online, and increasingly *less* confident about the information they get from their GPs. Nearly half of the consumers rely almost exclusively on search information to find medical information. The trends in the U.S. will apply even more strongly to Canada, which has even higher penetration rates than the U.S.[18]

Figure 17. Individuals using the internet to seek health information, selected countries, 2008 (%)



Although we have little comparable data available on Canada, the uptake of e-health among professionals seems to be much lower than among citizens , at least in terms of the use of (stand-alone) electronic patient health records. The low adoption rate of EHR among physicians is a significant impediment to the Canadian e-health agenda (Canadian Medical Association, 2008).

Figure 18. Primary care doctors' Use of stand-alone Electronic Health Records, 2006 (Beal at al., 2007)



[18] The percentage for the U.S. is 44% in 2007 – thus on par with The Netherlands percentage in 2008.

Obviously, two important disclaimers should be made. First, the use of internet by professionals to seek medical information is only weakly related to the use of EHRs.[19] Thus it could be that the actual use is much higher among Canadian GPs. Secondly, and more importantly, the figures are rather outdated and much has been improved since 2005. We have already seen in section 2 that the use of internet by GPs to search prescribing information and for continuing education has continued to grow quickly in Europe.[20]

With regard to the specific situation in Canada, it is expected that in 2010, five (out of 13) provinces will have a fully interoperable (thus networked) EHR system with patient information about historical drug, laboratory, diagnostic imaging, some hospital clinical reports, and immunization data regardless of where it originated (Canada Health Infoway, 2008).

In short, in the current situation the uses of the internet by citizens and by professionals are strikingly different. Although the use of e-health by professionals might be at a turning point, presently the use by citizens is much higher than by professionals. This result is in line with the finding of the macro model that – at least at this moment – the use of e-health by citizens is a *substitute* rather than a supplement to regular face-to-face health care. In the particular case of Canada, the apparent lack of GP's seems to push citizens towards the use of internet to find medical information.

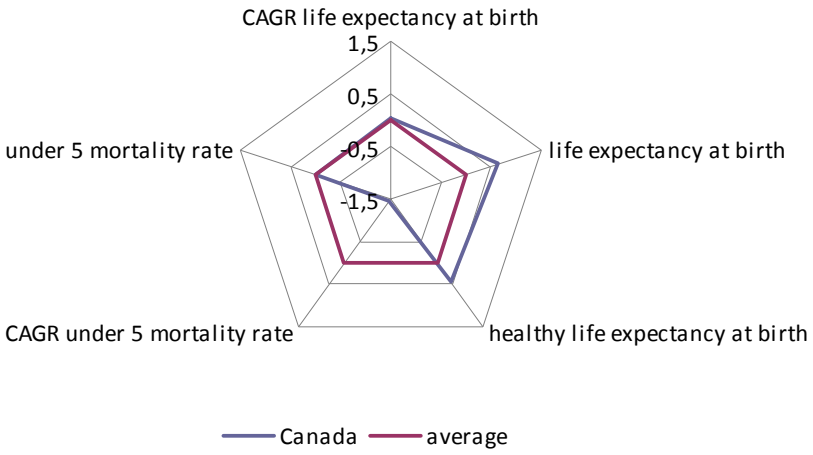
4.2.4 Impact

The use of ICT by citizens has clearly led to a change of attitude of patients towards GPs and health care institutions. Thus in terms of *perception* ICT has already had a significant impact on health care. With regard to the *direct effects* of ICT, in terms of effectiveness and efficiency of the health care system, the actual impact remains to be seen.

[19] For EU27, R^2 between the use of (stand-alone) EHR's and searching medical information on the internet is 0,23. However the latter sharply increases among countries that have a very high penetration rate of EHR use.

[20] Use of internet to search for prescribing information rose from 35% in 2002 to 62% in 2007, and use of internet for own continuing education from 45% to 82%.

Figure 19. Impact in Canada: Effectiveness (performance) of the health care system

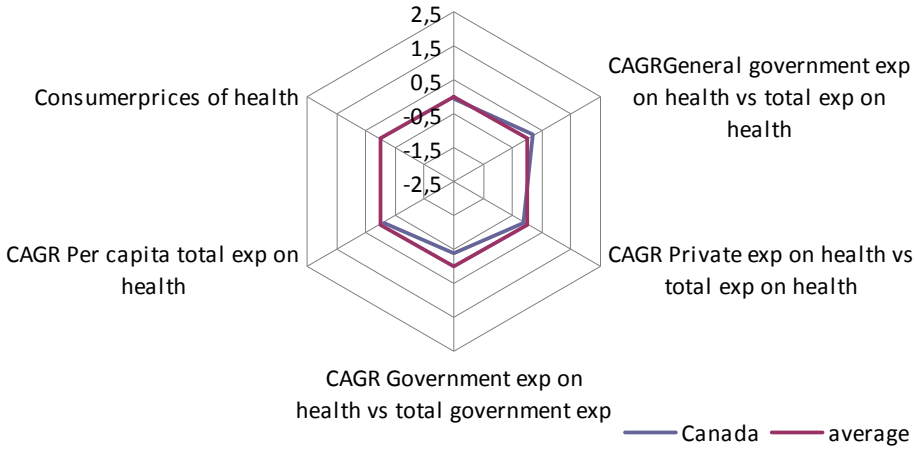


With regard to effectiveness – presumed improvements in the health situation – Canada does not perform particularly well. It has a relatively favourable starting position, with high (healthy) life expectancy and average infant mortality rates, but the growth rates have been respectively average and far below average.[21]

Relative growth in government expenditure on health care has been less strong in Canada than in other countries. At first glance this might indicate that some efficiency gains have occurred. Note that one of the key findings of the macro model is that the use of e-health increases rather than decreases expenditure on health care. Consequently this could mean that Canada is not a front runner in the use of e-health. However it remains to be seen whether the presumed efficiency gains have really occurred. It seems that the increasing costs of health care have partly shifted to the private sector (growth of *total* expenditure on health care has been on par with the average) and predominantly to the consumers (witnessed by the shortage of doctors and hospital beds).

[21] For the variables Life expectancy and Infant mortality we found no correlation between high initial scores and growth rates – thus the favorable starting position does not work against Canada.

Figure 20. Impact in Canada: Efficiency of the health care system



4.3 4.3 Denmark

4.3.1 Context

Denmark is a country with a typical Scandinavian structure -- a strong welfare state with universal coverage of health services. All Danish residents have free access to GPs and hospital care. The health system is almost entirely financed by the government. This situation is somewhat comparable to the Canadian situation with the important difference that all hospitals are owned by the government. Up until recently, the counties were also responsible for the funding of the system. However, contrary to the global trend of decentralization in 2007, the financing was centralized at the national level (Standberg-Larsen et al., 2007).

The general practitioners are the key actors in the Danish system. They are the gatekeepers to the hospitals. The Danish health system is built around the GPs. They are, however, tightly regulated by the regional government. The counties decide upon the number and location of practitioners. Thus the counties can and do push the implementation of e-health top-down.

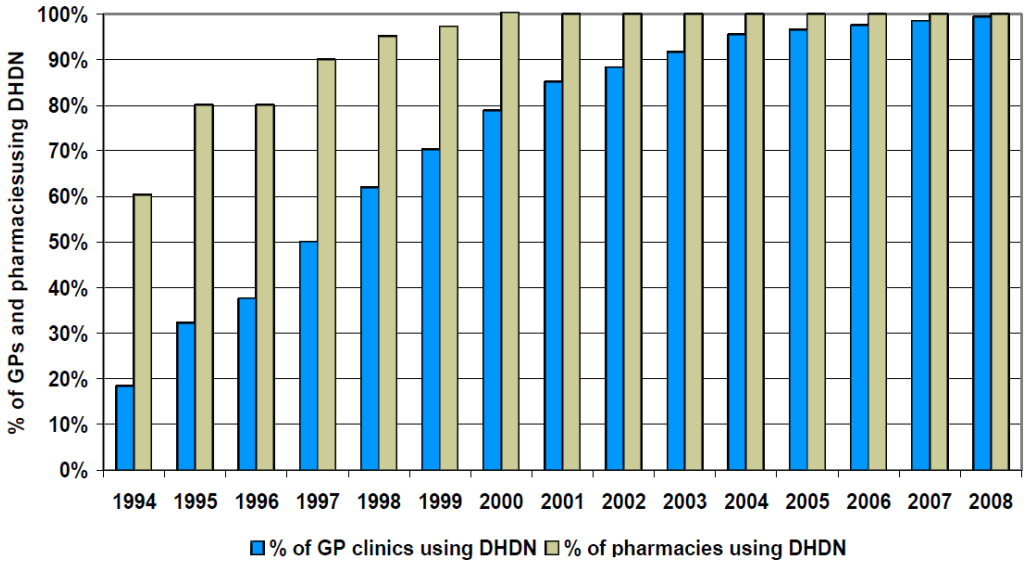
The free and omnipresent access to health care has not translated into a favourable general health situation. On the contrary, Denmark performs poorly on such basic indicators as life expectancy and infant mortality. Some evidence suggests that the poor health records are not so much due to the ineffectiveness of the health care system as to the particularly unhealthy life style of the Danish, which is characterized by high consumption of alcohol, fatty food and tobacco (Juel, Bjerregaard, and Madsen, 2000).

4.3.2 Readiness

The Danish Health Data Network (DHDN) is the showpiece of the Danish government and – literally – the information backbone of the health care system. DHDN is a reference for many countries that implement e-health systems. DHDN started as a

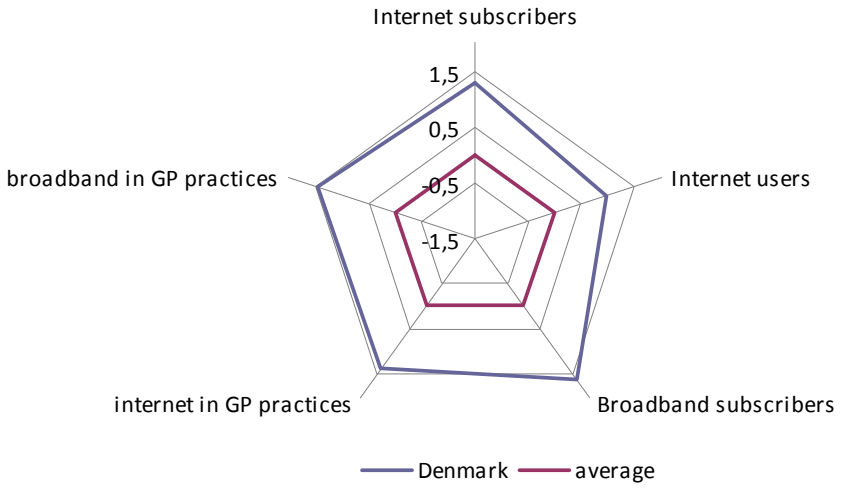
small regional network on the island of Funen in the early 1990's. There are several other similar – and usually bigger -- regional initiatives around the world (e.g., Netcare in Alberta, Canada and Diraya in Andalusia, Spain). What is unique about DHDN is that it was successfully scaled up to the national level, and that the implementation was done in a relatively short time. The technical roll-out was done in just two years (1994-1996). Connections to the network have grown since then at a steady pace. In 2000 all pharmacies were connected to the network and in 2005 nearly all GP clinics were connected.

Figure 21. Diffusion of the Danish Health Data Network (DHDN), 1994-2008



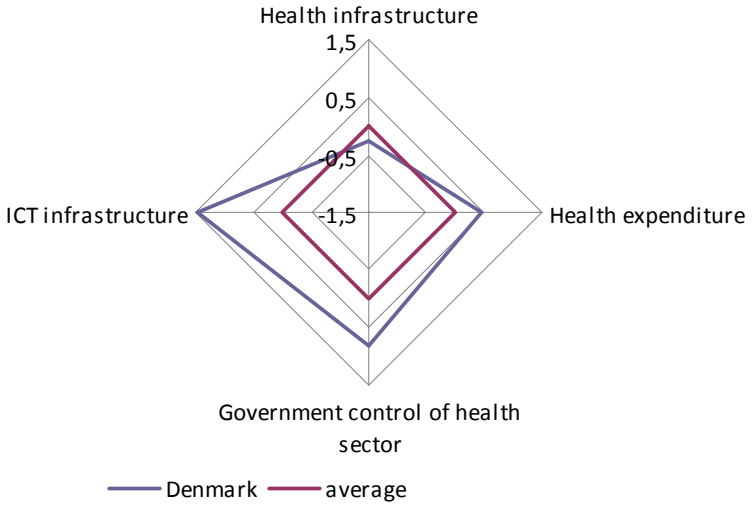
The DHDN is built around GPs. They are the point of departure for most of the patients. From there, services that citizens may need access to include pharmacists, diagnostic services at hospitals, specialist consultation at hospitals, referral to a hospital, if admitted, discharge from a hospital, and transfer to home care and care home services. Effective access to these by citizens depends on efficient and effective communication between healthcare providers (Wanscher, Pedersen, and Jones, 2006).

Figure 22. ICT Readiness in Denmark



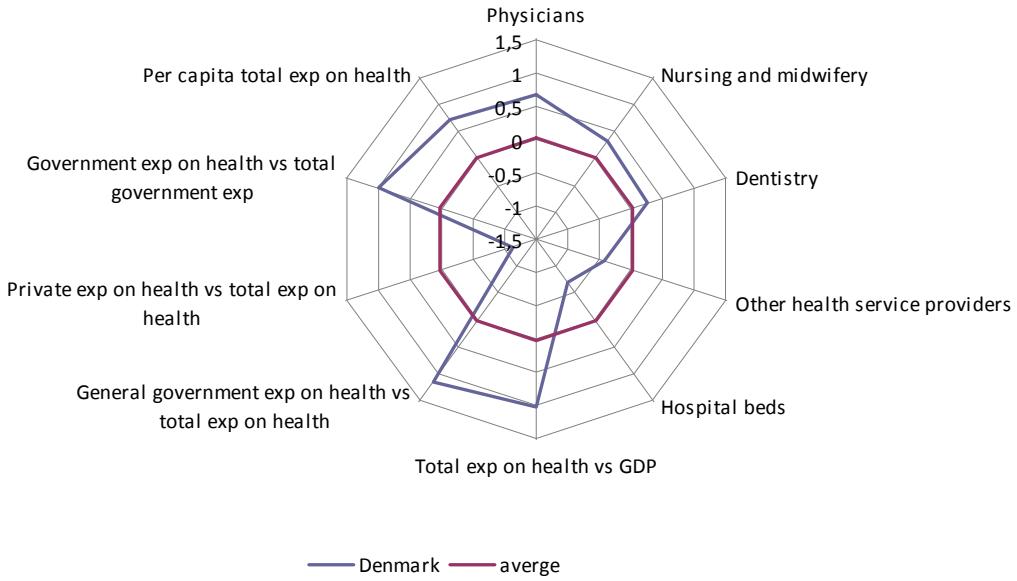
A direct result of the implementation of the DHDN is that the ICT readiness is extremely high in Denmark. It is, in fact, by far the highest in Europe and probably in the entire world. Nearly all GP's, pharmacies, hospitals and labs are connected by broadband networks. The successful and fast uptake of DHDN can to a large extent by explained by the particular institutional arrangement in Denmark, with the strong steering role of the regional governments. This is also reflected in the government expenditure on health care, and the government control of the health sector, which is far above average in Denmark.

Figure 23. Overview of Readiness in Denmark (Component)



The relatively low score on Health infrastructure is mainly determined by the shortage of hospital beds, not by a shortage of medical personnel. On the contrary (thus very different from the situation in Canada), the number of physicians is well above the OECD average (see next figure). In the expenditure figures, we find again the very dominant role of the government and thus the marginal role of the private sector.

Figure 24. Health Care Readiness in Denmark



In short, the Readiness in Denmark is very high but this does come at the cost of high public expenditure on health care.

4.3.3 4.3.3 Use

The national roll-out of DHDN is instrumental to the further implementation of e-health in Denmark. The use of e-health has even become critical to the functioning of the health care system at large. Hospitals are mandated to use EHR. This is already reflected in the following figure. Penetration rates for B2B e-health applications are very high with the exception of the non-committal use of electronic appointment systems.

Figure 25. Use of B2B e-health applications in Denmark

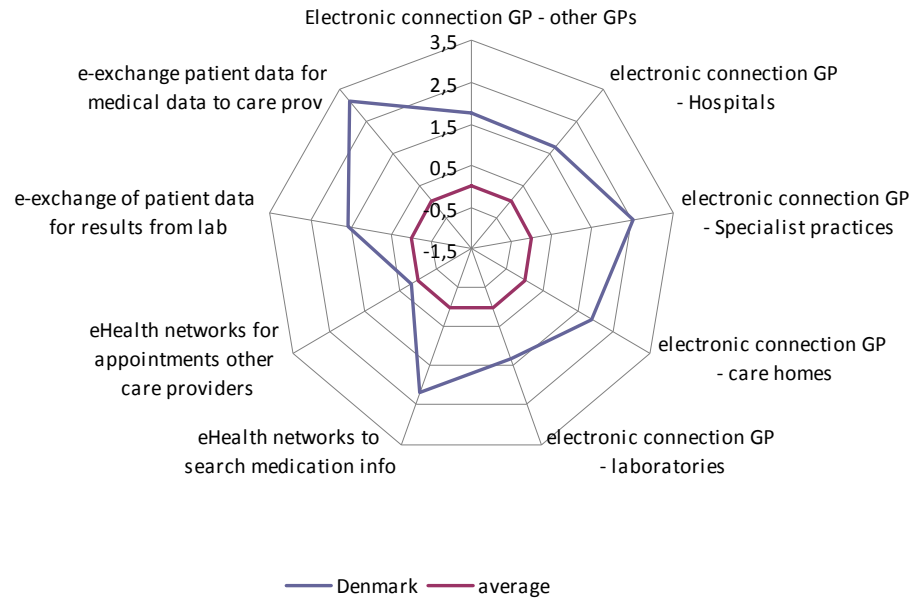
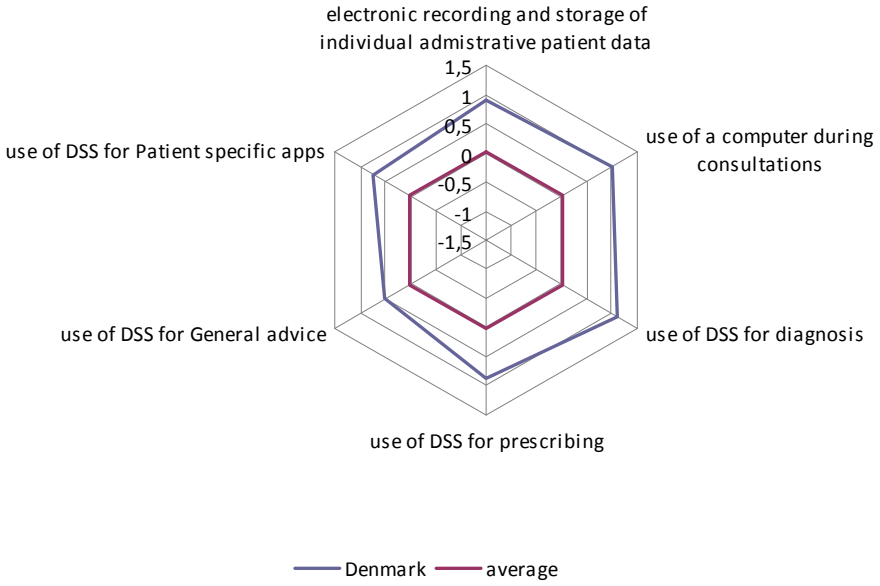


Figure 26. Use of stand-alone e-health applications in Denmark



Uptake of stand-alone e-health applications is also very high in Denmark. This is because both networked (B2B and B2C) and stand-alone use are strongly related to the general e-health maturity of a country. Thus there is no sequential adoption of e-health, with saturation in stand-alone use followed by saturation in networked use. Both types of use are directly related to maturity and develop simultaneously and are, at least in the case of Denmark, also intertwined. The extensive use of local EHR systems has facilitated the recent establishment of a centralized server to store all medical data.

Another use of e-health that is unique for Denmark is the electronic connection between GP practices and patient homes. Denmark is the only country in the reference group that uses e-health this way. The extent of the e-health network, that is, the scope of the electronic exchange of medical and administrative data, is also already much wider than the core group of GP's, labs and hospitals. The low score on exchange with insurance companies is entirely due to the particular set-up of the Danish health care system where there is little need for direct contact between GPs and insurance companies (goes indirectly via public health authorities – hence the very high score there). Again we find relative low scores for the use of appointment systems, which is a distinctively different type of e-health application and a relative marginal component in the DHDN system.

Figure 27. Use of B2C e-health applications in Denmark

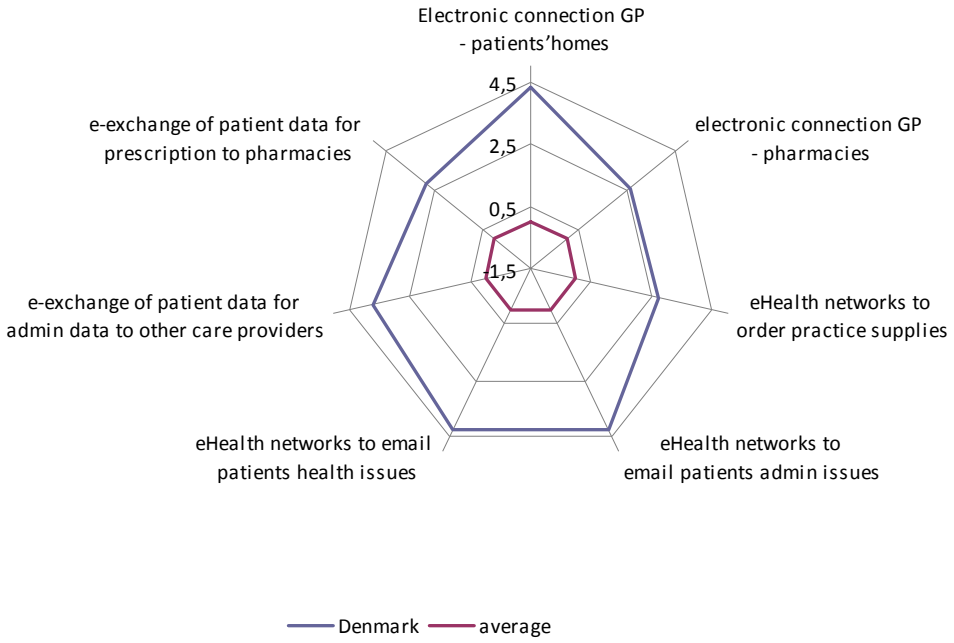
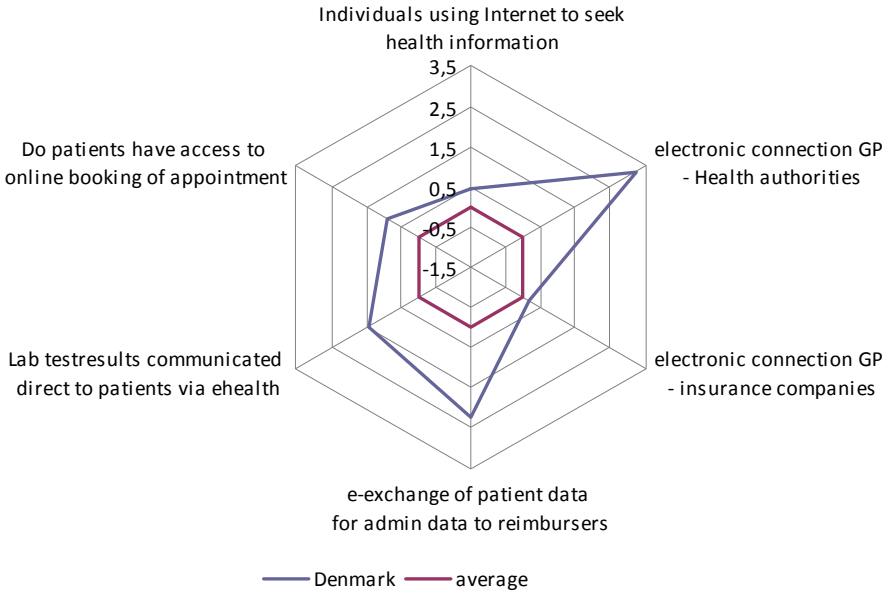


Figure 28. Use of e-health applications by citizens and for communication with authorities and insurance companies in Denmark

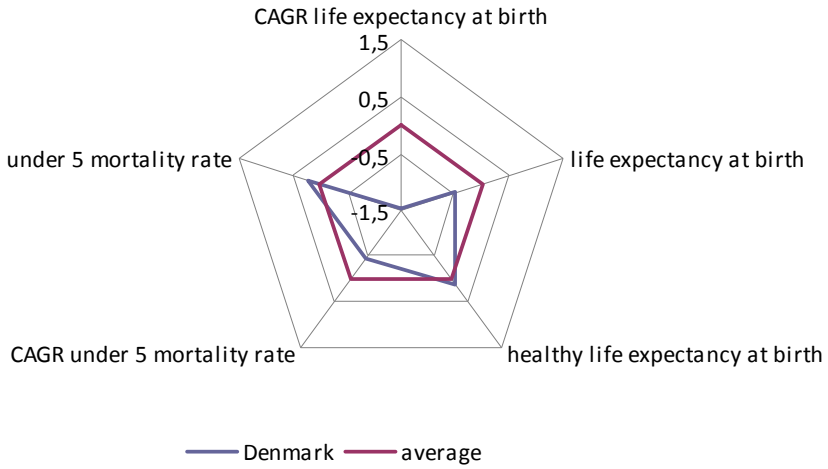


Although the use of the internet by citizens to seek health information is above OECD average it is significantly below the (very high) use in Canada. The situation in Denmark seems to be somewhat contrary to the situation in Canada. Use of e-health among professionals is very high but use among citizens is just slightly above average. This corroborates again the finding of the macro model that the use of e-health by citizens is a substitute for, rather than a complement of, the use of regular health care. Given the high degree of accessibility of the latter – GP density is high and use is free – there simply is less need to consult the internet.

4.3.4 Impact

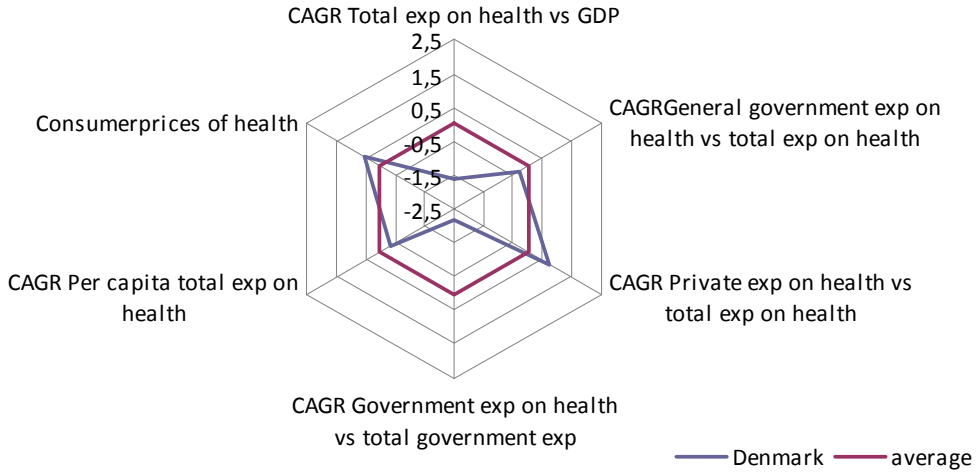
Denmark is clearly one of the global frontrunners in terms of Readiness and Use of e-health. If the use of ICT already has a significant impact on health care, it should be visible in Denmark. Intriguingly, the Danish health care system performs rather poorly, both in terms of effectiveness and efficiency. With regard to the effectiveness one could put forward the counterargument that the worse health situation is due to the unhealthy life style of the Danish. However this is probably not enough to entirely explain away the presumed positive effect of the use of ICT. Most telling is that the *growth rates* also show a rather grim picture. In the same period that the use of e-health took off (since 2000), the life expectancy and infant mortality rates have only further deteriorated.

Figure 29. Impact in Denmark: Effectiveness (performance) of the health care system



Another widely assumed impact of the use of ICT in e-health is cost reduction. With a particular reference to Denmark, Stroetmann et al. (2006) claim that GPs in Denmark can work more efficiently due to the use of DHDN. However, despite the pivotal role of DHDN, the impact on the efficiency of the system *as a whole* seems to be rather limited so far. Government expenditure on health care has even increased sharply. This is in line with the finding from the macro model that the use of B2C e-health applications increases rather than decreases expenditure on health care.

Figure 30. Impact in Denmark: Efficiency of the health care system

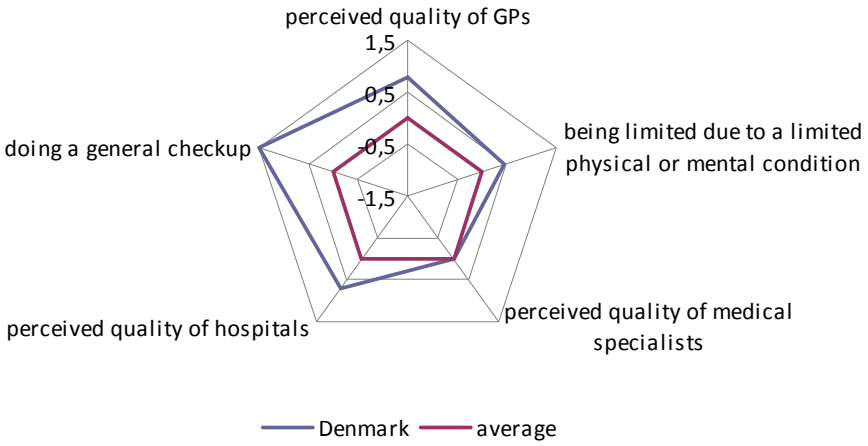


Finally, *perceptions* on the functioning of the health care system are at least quite favourable for the Danish system, with the exception of the quality of medical specialist. The perception of the quality of GPs is well above average but this is also the case in Spain, which is at a much lower level of e-health maturity. Given the central position of GPs in the Danish health care system, one would have expected a higher score due to the widespread use of DHDN. The perception of one's health ("being limited…") is strongly related to the use of the internet and is thus rather

high in Denmark. However, it can safely be assumed that Canada scores much higher on this particular variable.

The indicator “doing a general checkup” requires careful interpretation. It has been argued in section 1 that the shift from curative to preventive health care is one of the key solutions in containing health care costs. As such, the high incidence of checkups in Denmark could be regarded as a positive development, and as an indicator for the successful implementation of e-health in Denmark. However, in our (macro) model the variables “doing a general checkup” and “being limited due to a limited physical or mental condition” are strongly positively related. In other words, people who perceive their own health condition as bad will more often have a general checkup than people who have a more positive perception of their health condition. Thus in the long run we might be arguing that the shift towards preventive health care – as being indicated by an increase in doing checkups – improves the quality of health care, but in the current situation it is an indicator for the *negative* quality of a health care system. We should interpret the very high score of Denmark on doing general checkups in the light of the bad health care situation in the country, and therefore regard it as a strongly negative outcome.

Figure 31. Impact in Denmark: perceptions on the functioning of the health care system



In short, the impact of ICT on the Danish health care system so far has been limited at best. The health situation has deteriorated even as overall expenditure levels have increased.

4.4 4.4 Spain

4.4.1 Context

Average life expectancy in Spain is one of the highest in the world. One of the key drivers behind this is a very low infant mortality rate (Durán, Lara, and Van Waveren, 2006). The rates have been improving constantly since the 1970’s. During the same period the coverage of the health care system has expanded from less than 80% to nearly 100% of the inhabitants, including low-income groups and immigrant adults and families.

The Spanish health care system is similar to the Danish system. It is publicly funded (mainly through taxation) and provides universal coverage with free access to health care. The system is regionally organized but the national government is responsible for overall coordination of the system.

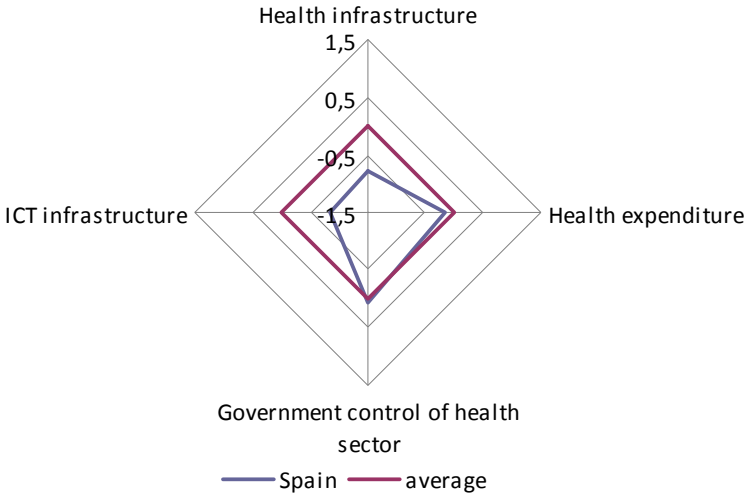
A major difference with the Danish situation is that hospitals are the central element in the Spanish health care system rather than GPs. National coordination, which was quite weak in the past (Solsten and Meditz, 1988), has substantially improved due, in large part, to the impact of ICT in national health programs. Nevertheless, due to a decentralized government system, there are still big differences in the advancement of e-health between the (autonomous) regions. Spanish citizens also feel that the most important action is for government to ensure that health services coordinate efforts with different public services to address wider health needs (Accenture, 2010).

Within the regions, the main problems are the coordination between hospitals and GPs, duplication in clinical records and diagnoses, and long waiting times and delays in treatment (Durán et al., op.cit.). One of the consequences of the long waiting times is the relative importance of private health care services in Spain. Approximately 15% of the population has taken out a form of private medical insurance to complement or as an alternative to the public health service (AngloINFO, 2010). Private medical companies have their own clinics, surgeries and laboratories. In the urban regions (especially Madrid and Barcelona), private funding of health care plays a much more important role than in the rural areas, where its share is negligible.

4.4.2 Readiness

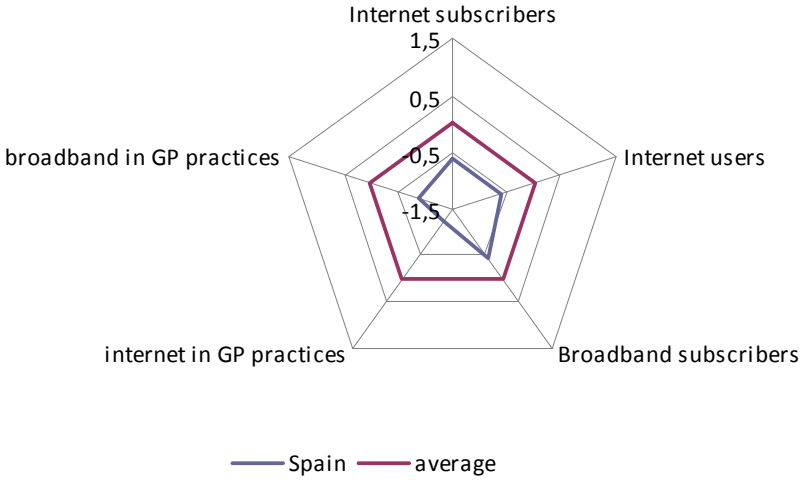
The differences between the regions also apply very much to Readiness. Whereas the overall e-health Readiness in Spain is below the OECD average, some regions are frontrunners in Europe. In Andalusia, the region with the largest population, the Diraya (Electronic Health Records) and Receta XXI (e-prescribing) systems are on par with the Danish DHDN. The overall low score on Readiness is due to low scores on both ICT infrastructure and health infrastructure. Both dimensions are further elaborated below.

Figure 32. Overview of Readiness in Spain (Component)



The low score on ICT infrastructure – and particularly the low internet penetration in GP practices – can be explained by the relatively low internet penetration in Spain. Although over the last years impressive strides have been made under Plan Avanza (Lanvin et al., 2010), Spain still lags behind the European average (ITU, 2010).[22] Other factors mentioned that have a negative impact on e-health readiness are the lack of training in new technologies for professionals, the rather conservative culture of health care providers and the fear that the doctor-patient relationship will alter (E-user, 2005). The latter is, obviously, not specific for Spain but occurs across all countries (see section 2).

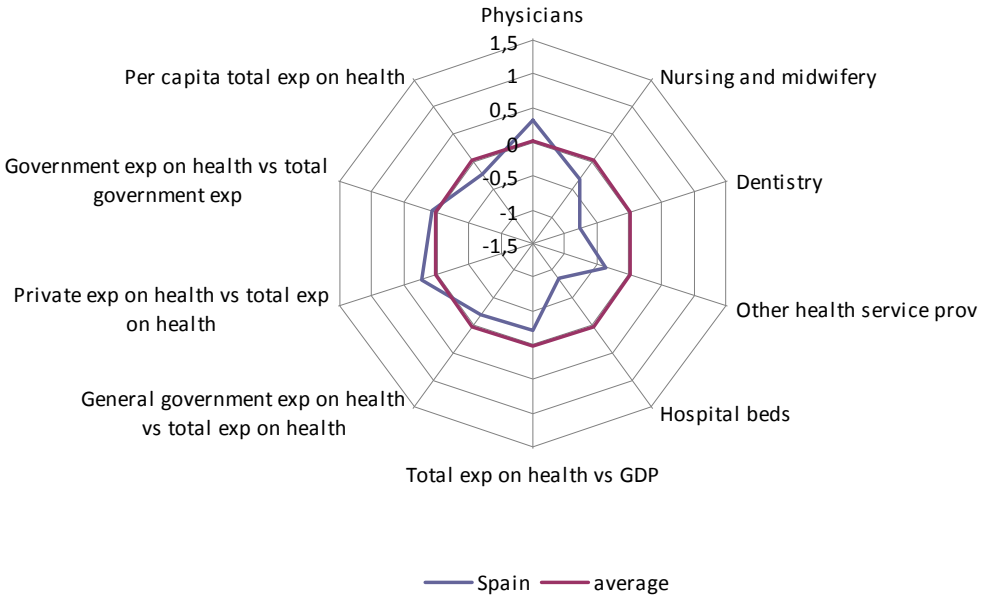
Figure 33. ICT Readiness in Spain



[22] Percentages for household internet access, household broadband access, and regular internet use by citizens in 2009 are respectively 54%, 51%, and 54% for Spain and 65%, 56%, and 60% for the EU average (EU27). With regard to access, the gap with the EU average has slightly increased (+1/+2%) during the period 2008-2009. In regular use, the gap has slightly decreased (-1%). Source: EuroStat 2010. Note that the figures in this chapter are generally based on 2008 data.

Given the excellent health situation in Spain, one would have expected a very high health care Readiness. After all, our macro model also showed that the quality of the health infrastructure and life expectancy are positively related. However, health care Readiness in Spain is relatively low. A positive is the number of physicians (especially compared to Canada). This means that the Spanish health care system functions very efficiently or, more likely, that the lifestyle of the Spanish is rather healthy.

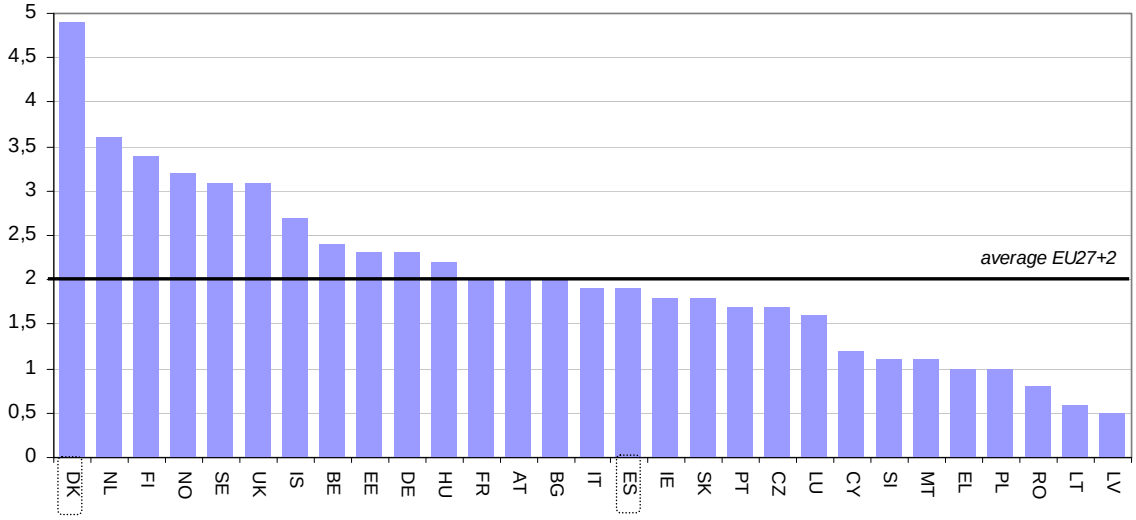
Figure 34. Health Care Readiness in Spain



4.4.3 Use

The situation with regard to Use is very similar to the situation with regard to Readiness. Large differences exist between the various regions. Some regions are frontrunners in the use of e-health but the overall situation is well below the OECD average. In Andalusia, over 80% of all GP's are connected to the Diraya/Receta XXI systems. Many medical professionals in Andalusia are already heavily dependent on the use of Diraya (EHR Impact, 2009a) and Receta (EHR Impact, 2009b).

Figure 35. Level of e-health maturity in all European member states, 2007 [13]



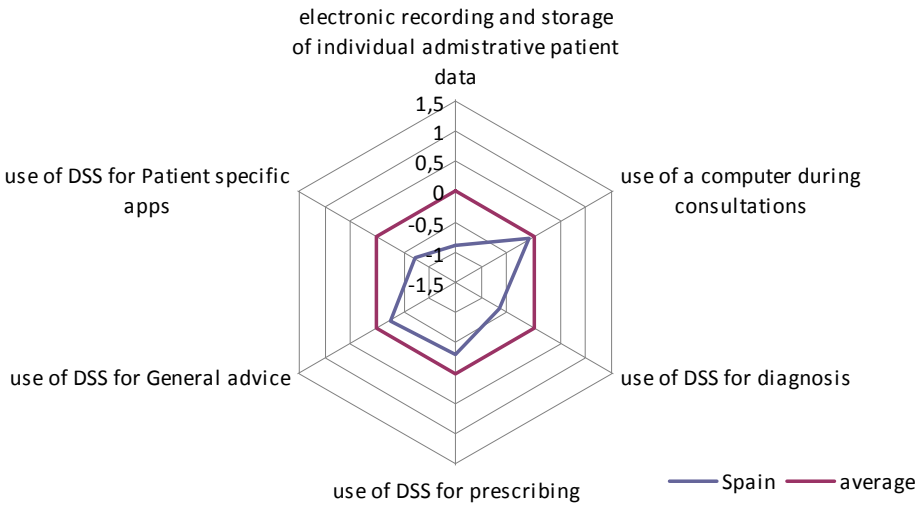
Source: Meyer, et. al, 2009

Overall, use of e-health in Spain is still just below the EU average. Nevertheless there has been a significant increase of use during the last few years in particular types of stand-alone, B2B, and B2C use. The establishment of a central node of the National Health Service for interconnection and data exchange between the autonomous regions has been a major driver. In 2009, all public healthcare centers were interconnected through a common network, and electronic health records, e-prescription (

Figure 36), and e-appointment (Figure 38) have become fully available (Lanvin et al., 2010). [23] The domestic market for specific e-health networking applications is also developing. Back in 2000, some internet service providers were already providing tailored products for the B2B and B2C health care market (Carlos III Institute of Health, 2000).

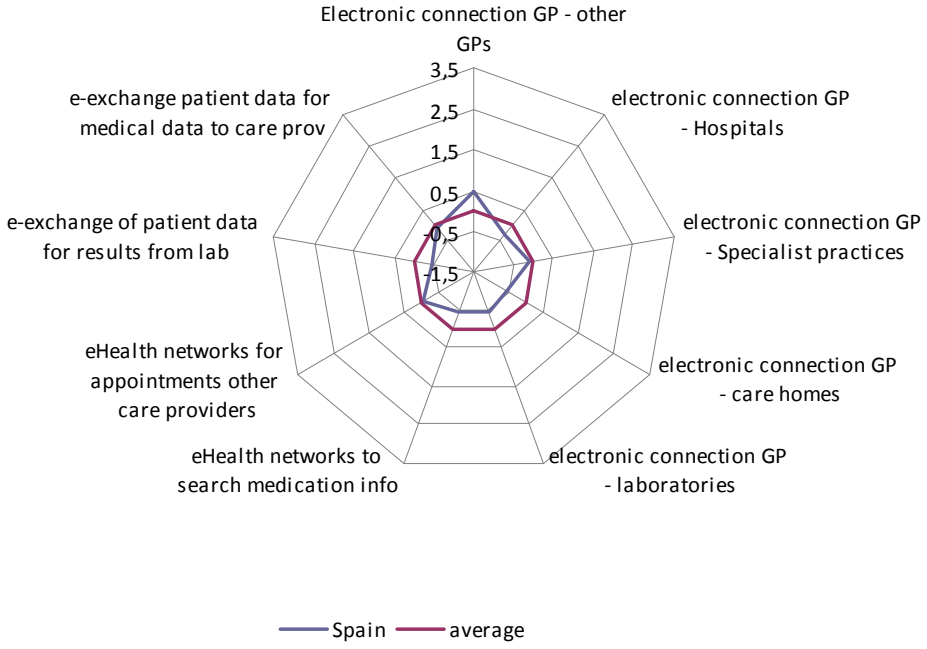
[23] Note that the figures are based on 2007 data and thus do not reflect the recent rapid changes in the Spanish ICT health infrastructure. For instance, in 2007 only 68% of all GP's stored patient records electronically – well below the EU27 average of 79%. In 2009, the Spanish Ministry of Health and Social Policy reports that 97% of all GP's have electronic access to their patients'records – against only 14% in Canada and 12% in the U,S, (Landvis et. al, 2010). This would mean that Canada and the U.S. rank far below the EU country with the lowest penetration rate, Latvia (which stood at 26% in 2007).

Figure 36. Use of stand-alone e-health applications in Spain



In stand-alone use, the fastest growth has been in the basic type of use, namely use of a computer during consultations. As has been argued before, stand-alone use does not precede but co-evolves with networked use. Thus the overall low scores on stand-alone use are a direct result of the modest e-health maturity of Spain.

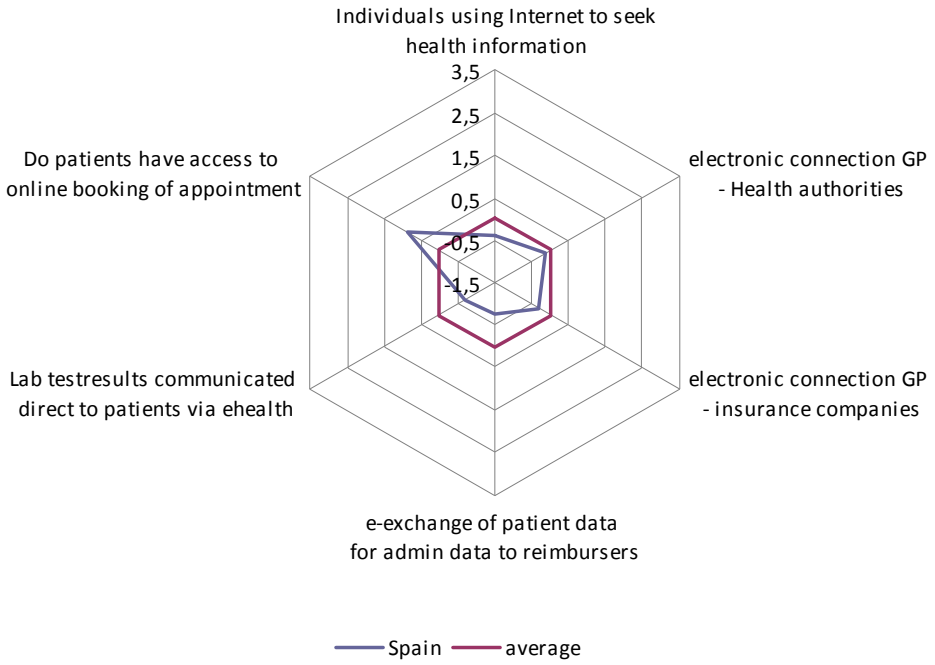
Figure 37. Use of B2B e-health applications in Spain



Most striking in the score for B2B use is the electronic communication with other GP's, which has grown above the EU average. Communication with specialists is now also on the EU average but given the central role of specialized care in Spain there is probably still a significant gap to close. Making appointments over the internet is also used relatively often in Spain, which is again reflected in the B2B figures. Note the

contrast with frontrunner Denmark where this particular type of use scores relatively low.

Figure 38. Use of B2C e-health applications in Spain

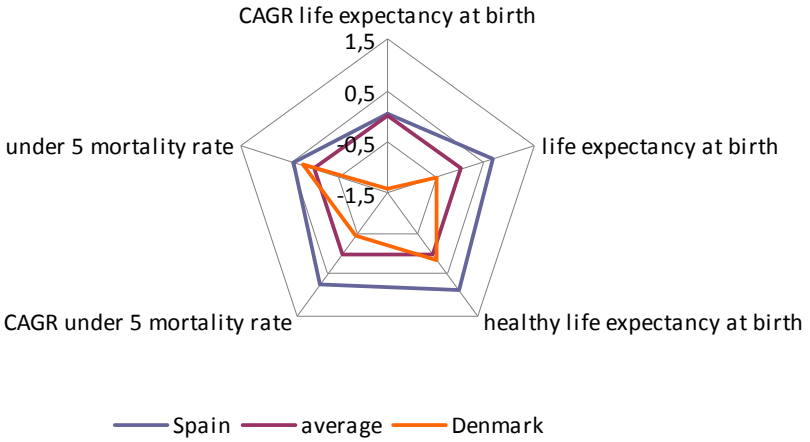


4.4.4 Impact

The situation with regard to e-health in Spain stands in sharp contrast to the situation in Denmark. However, we have seen that the leading position of Denmark has not particularly translated into significant improvements in the effectiveness and/or efficiency of the health care system as a whole. The other way around, Spain is not particularly a frontrunner in e-health but it is outperforming Denmark on every single Impact indicator (see

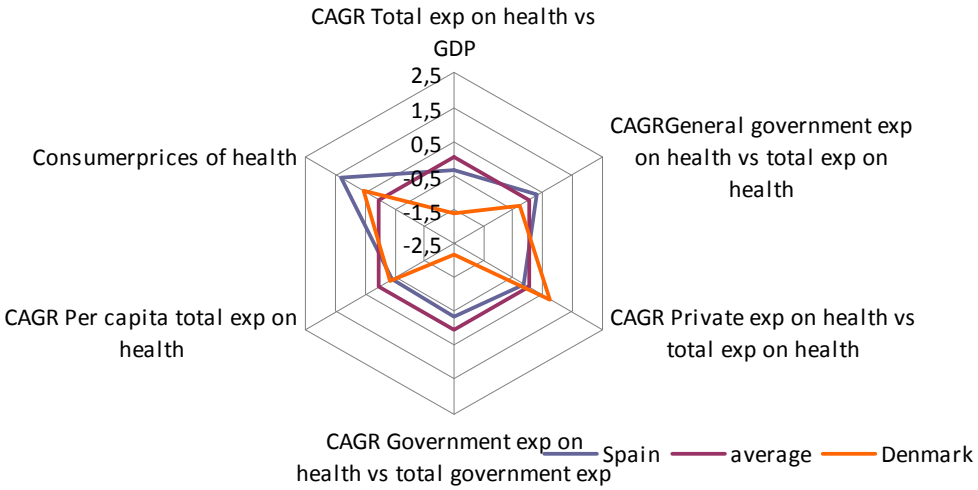
Figure 39). Thus the modest use of e-health does not seem to be a major hindrance to the performance of the health care system as a whole.

Figure 39. Impact in Spain: Effectiveness (performance) of the health care system



If we turn to cost efficiency, Spain again outperforms Denmark on every indicator, with the exception of growth of private expenditure on health care. The latter can, however, be entirely explained by the very low starting position of private expenditure in Denmark. The relative efficiency of the Spanish health care system is all the more impressive if we take into account that Spain has one of the most aged populations in the world. As has been argued in section 1, ageing is the key driver for the cost explosions in health care worldwide.

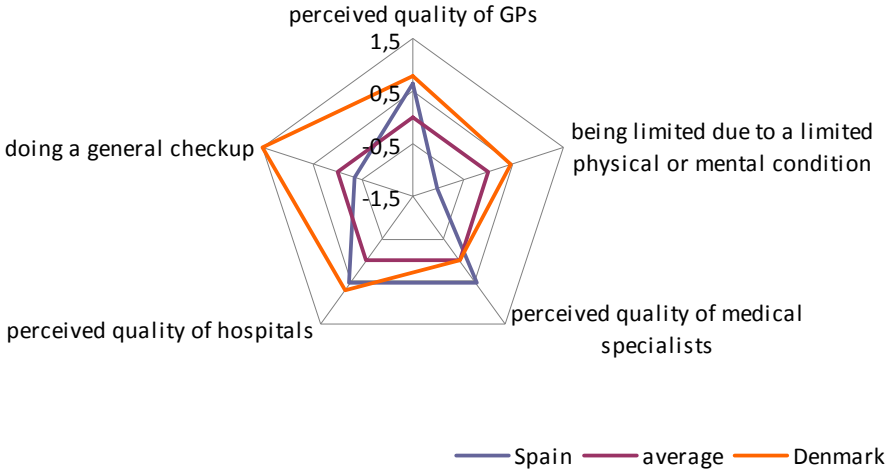
Figure 40. Impact in Spain: Efficiency of the health care system



At first glance, when it comes to perceptions of the functioning of the health care system Denmark finally scores significantly better than Spain across the board. However, as has been explained in the Danish case, “doing a general checkup” and “being limited due to a limited physical or mental condition” are driven by the same underlying indicator, namely the general health condition in a country. The Spanish life style appears to be much healthier than the Danish one. Consequently, Spanish have a relative positive perception on their own health (thus a low score on the ‘being limited’ variable) and have less need to regularly do general checkups (thus also a low score). If we take these interrelated phenomena into account, the image

changes completely. On the remaining three variables, Spain scores either similar or better than Denmark. The latter high score – the perceived quality of medical specialists – is probably partly due to the particular setup of the Spanish health care system, with a central role for specialized care.

Figure 41. Impact in Spain: perceptions on the functioning of the health care system



In short, although both in Denmark (DHDN, [Stroetman et al., 2006]) and in Spain (Diraya [EHR Impact 2009a] and Receta [EHR Impact 2009b]) bold claims have been made about quality (e.g., error reduction, prompt monitoring by pharmacists) and efficiency (e.g., less GP visits by long-term patients) improvements, at the level of the health system at large we find little evidence to support these claims. Without doubt, Denmark is far ahead of Spain in terms of Readiness and Use of e-health. However it is also clear that the Impact of the Spanish health care system in terms of quality and efficiency is considerably better than the Impact of the Danish system. Widening the scope of the comparison to all 27 + 2 EU member states (that data set of section 2) we found no correlation whatsoever between the independent variable e-health maturity (see Figure 35) and any of the key Impact indicators, be it the relative decrease of life expectancy or the relative decline [cf. OPFACT1] of infant mortality [cf. OPFACT2] over the last couple of years, or the decreasing growth of per capita expenditure on health care [OUTCOME3].

5 Overall conclusions

In this concluding section we summarize the most important overall findings:

1. **The widespread diffusion of the internet has greatly boosted the use of ICT in health care**

Contrary to other social domains ICT has already been used extensively in the health system at least since the early 1970's. However, the early use of ICT was limited to stand-alone applications such as local storage of patient records. The internet greatly boosted the use of ICT and networked applications. The presence of computers and internet connections has grown rapidly over the last couple of years. This growth, combined with the introduction of a growing number of ICT applications related to health, has opened new avenues for development of the ehealth concept. However, at this stage, we found that both for citizens and professionals, Use is strongly correlated with Readiness; hence the rapid growth of ICT infrastructure has translated into a fast growth of the Use of e-health applications, with the exception of some types of use [see point 4].

2. **Use of networked e-health applications is not sequential to use of stand-alone e-health applications**

Long-term trends in IT represent paradigm shifts in business processes. Historically, we have seen at least three of such 15-20 year waves: from centralised mainframes (enterprise view of information) via distributed personal computers (individual view of information) to interconnected computers (shared view of information). Likewise, we expected to see that the use of stand-alone applications preceded the use of networked applications. However, we found that both types of use are actually strongly correlated to the overall e-health maturity of a country. The two types of use develop simultaneously and in many cases reinforce each other. Thus they develop in parallel rather than serially.

3. **Adoption of stand-alone and networked e-health applications have different adoption patterns**

There is still a marked difference between stand-alone and networked applications and the two types should not be confused. For instance, stand-alone electronic health records (EHR) were in use since at least the 1970's and they have been rapidly adopted by GPs since the 1980's. The new generation of networked EHRs – and especially the uniform national EHRs, are another piece of (bitter) cake. Privacy concerns have delayed the national roll-out in many countries around the world. In the absence of a national system (and due to incompatibility between local and regional systems), the electronic exchange of a health records and administrative data on a national scale is still fraught with difficulties. On the contrary, where such national systems have been implemented (as in Denmark and Sweden), the use of e-health has grown very rapidly. The disadvantage of not having a national network, and the advantage of

having one, is clearly illustrated by the Telemedicine clinic case.[24] According to its own mission statement, the private Spanish-Swedish company Telemedicine clinic uses telemedicine to overcome constraints of state borders (Cikowski, 2006). In practice this boils down to dozens of Spanish radiologists providing medical services to Swedish, Danish and English hospitals over the Swedish network and to a much lesser extent to domestic Spanish hospitals.

4. **Telemedicine's potential as a main dimension of ehealth has not yet been fully realized**

Health care systems around the world face increasing pressure due to autonomous yet interrelated trends such as the ageing of populations and the increase of chronic diseases. As a consequence total expenditure on health care is supposed to double in the next twenty years. Technology is supposed to be one of the ways out, especially when it is supported by major organizational changes such as a shift from curative to preventive health care. Telemedicine is one of the early killer applications for e-health and is supposed to play a pivotal role in the containment of the ever-increasing health care costs, and also in the aforementioned shift towards preventive health care. However the use of telemedicine has hardly grown during the last couple of years and adoption rates remain very low. Unlike other uses of ICT in the health arena, such as storage of patient records, telemedicine requires complex changes in procedure and meets cultural resistance, factors that undoubtedly have retarded its growth.

5. **Economic strength is the strongest determinant for the Impact of health care systems**

Economic strength (GDP) still has the greatest impact on the outcome of health care systems than any of the other components. Healthy life expectancy is directly related to the welfare in a country. Similarly, inhabitants from richer countries tend to think that the health care system in their country performs relatively well. This simply means that the relative contribution of ICT to the outcome is still modest, at least to this point. One of the few direct links that we found between IT-Readiness and (health) Impact at the macro level is having a clear national strategic information strategy.

6. **Efficiency gains create differing perceptions about quality change**

In the perception of GPs, there is no direct effect of the use of ICT on the quality of health care provided. One of the reasons for this is the issue of not whether ICT is being used, but rather *how* it is being used. In other words, the quality of the implementation largely determines the eventual impact of the use of ICT. This applies to the use of ICT in general but is especially important to the critical environment of health care practices. With regard to the use of ICT GPs feel that the perceived efficiency gains [see point 5] lead to increased workloads and an increase in the number of patients treated per day. This in turn leads to a deterioration of the scope of services offered and of the doctor-patient relationship.

[24] http://www.telemedicineclinic.com/index.php/en

Patients have a different perception than GPs, according to the evidence that we found. Patients value efficiency improvements (in terms of a reduction in waiting times for treatments) more highly than eventual quality deterioration. It may well be that the difference in perceptions between GPs and patients are attributable to temporary transition costs that disappear as best practices incorporating efficiencies and cost savings become more firmly established.

7. The widespread use of the internet has a profound impact on the doctor-patient relationship

The relationship between doctor and patient is affected by the sharp increase in the use of internet [see point 1]. Citizens have eagerly embraced the internet as a readily available source of medical information whereas traditionally their doctor was the sole source of information (and consequently, the relationship was rather hierarchical). The internet has greatly empowered and emancipated patients. Over the last couple of years health care consumers have gained increasing confidence in the medical information they find online, and have lost some confidence in the information they get from their GPs. The most avid users of medical information on the internet are also most concerned about their own health. It is exactly this group that questions the quality of the diagnosis and treatment of their GPs the most.

It might come as no surprise then that in many countries GPs are wary about patients using the internet to find medical information. At the same time, they turn en masse to the same internet themselves to look for prescribing information and to continue their own education, a positive impact on the health care system.

8. E-health increases the reach of the health care system

We observe a negative correlation between the Readiness of the health infrastructure and the Use of e-health by citizens. The more doctors and specialists there are available in a country the less need there is for a citizen to resort to e-health (situation in Denmark) and the other way around (situation in Canada). It could also be that countries with a less developed conventional health system have an urge to modernise their infrastructure via e-health (the "leapfrogging" argument). Thus, e-health increases the reach of health care provision to a country's population. This means that without e-health, fewer people would receive health care, since the available medical personnel would be the only resource to provide this care.

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Appendix I: Overview of source data

Variable	N	Source	year	type of measurement
OPFACT_CAGR life expectancy at birth	193	WHO (2009) World Health Statistics	2000-2007	statistical data
OPFACT_Life expectancy at birth	193	WHO (2009) World Health Statistics	2000	statistical data
OPFACT_Healthy life expectancy at birth	193	WHO (2009) World Health Statistics	2007	statistical data
Neonatal mortality rate	191	WHO (2009) World Health Statistics	2004	statistical data
infant mortality rate	193	WHO (2009) World Health Statistics	2000-2007	statistical data
Infant mortality rate	193	WHO (2009) World Health Statistics	2007	statistical data
OPFACT_CAGR Under-5 mortality rate	193	WHO (2009) World Health Statistics	2000-2007	statistical data
OPFACT_Under-5 mortality rate	193	WHO (2009) World Health Statistics	2007	statistical data
Maternal mortality ratio	169	WHO (2009) World Health Statistics	2005	statistical data
Antenatal care coverage_1	123	WHO (2009) World Health Statistics	2000-2008	statistical data
Antenatal care coverage_4	85	WHO (2009) World Health Statistics	2000-2008	statistical data
Births attended by skilled health personnel	178	WHO (2009) World Health Statistics	2000-2008	statistical data
Unmet need for family planning	68	WHO (2009) World Health Statistics	2000-2006	statistical data
Contraceptive prevalence	108	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_Physicians	191	WHO (2009) World Health Statistics	2000-2007	statistical data
RHEALTH_Nursing and midwifery personnel	191	WHO (2009) World Health Statistics	2000-2007	statistical data
RHEALTH_Dentistry personnel	187	WHO (2009) World Health Statistics	2000-2007	statistical data
RHEALTH_Other health service providers	165	WHO (2009) World Health Statistics	2000-2007	statistical data
RHEALTH_Hospital beds	181	WHO (2009) World Health Statistics	2000-2008	statistical data
OUTCOME_CAGR Total exp on health vs GDP	192	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_Total exp on health vs GDP	192	WHO (2009) World Health Statistics	2006	statistical data
OUTCOME_CAGR General government exp on health vs total exp on	192	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_General government exp on health vs total exp on health	192	WHO (2009) World Health Statistics	2006	statistical data
OUTCOME_CAGR Private exp on health vs total exp on health	192	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_Private exp on health vs total exp on health	192	WHO (2009) World Health Statistics	2006	statistical data
OUTCOME_CAGR Government exp on health vs total government	192	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_Government exp on health vs total government exp	192	WHO (2009) World Health Statistics	2006	statistical data
OUTCOME_CAGR Per capita total exp on health (PPP int. $)_2000-	187	WHO (2009) World Health Statistics	2000-2006	statistical data
RHEALTH_Per capita total exp on health (PPP int. $)_2006	187	WHO (2009) World Health Statistics	2006	statistical data
CAGR Gross national income per capita	172	WHO (2009) World Health Statistics	2000-2007	statistical data
RECONOMY_Gross national income per capita	175	WHO (2009) World Health Statistics	2007	statistical data
RPOLICY_National information policy or strategy _policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_National ePolicy or eStrategy _policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_National eHealth policy or strategy _policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Procurement policies or strategies_policy	110	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Public funding_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Private funding_policy	110	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Public-private partnerships_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_eHealth standards_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Citizen protection_policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Equity_policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Cultural diversity_policy	109	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_National ICT in health development plan_policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Policy on affordability of infrastructure_policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Intersectoral and non-governmental cooperation_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Access to international electronic journals_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Access to national electronic journals_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_National open archive_policy	110	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Health information for the general public_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Multilingual projects_policy	108	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Translation and cultural adaptation_policy	108	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Training on ICT_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_Continuing education on ICT_policy	112	WHO (2005) Global eHealth Survey	2005	expert survey
RPOLICY_eLearning in health sciences_policy	111	WHO (2005) Global eHealth Survey	2005	expert survey
RICT_Internet subscribers	171	ITU	2008	statistical data
RICT_Internet users	188	ITU	2008	statistical data
RICT_Broadband subscribers	181	ITU	2008	statistical data
USECIT_Individuals using Internet to seek health information	33	EUROSTAT	2008	statistical data
OUTCOME_Consumer prices of health	31	EUROSTAT	2008	statistical data
OPPERC_Perceived quality of GPs	29	EC (2007) Eurobarometer: Health and long-term care in the EU	2007	random survey
OPPERC_Being limited due to a limited physical or mental condition	29	EC (2007) Eurobarometer: Health and long-term care in the EU	2007	random survey
OPPERC_Perceived quality of medical specialists	29	EC (2007) Eurobarometer: Health and long-term care in the EU	2007	random survey
OPPERC_Perceived quality of hospitals	29	EC (2007) Eurobarometer: Health and long-term care in the EU	2007	random survey
OPPERC_Doing a general check-up	29	EC (2007) Eurobarometer: Health and long-term care in the EU	2007	random survey

Variable	N	Source	year	type of measurement
Use of computers in GP practices	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
RICT_Use of internet in GP practices	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
RICT_Use of broadband in GP practices	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of electronic recording and storage of individual administrative patient data	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of a computer during consultations	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of DSS for diagnosis	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of DSS for prescribing	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of DSS for General advice	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Use of DSS for Patient specific apps	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and other GPs	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and Hospitals	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and Specialist practices	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and Health authorities	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and insurance companies	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and patients' homes	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and care homes	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and laboratories	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic connection between GP and pharmacies	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Using electronic health networks to search medication	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Using electronic health networks to order practice supplies	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Using electronic health networks to make appointments w/other care providers	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Using electronic health networks to e-mail patients admin	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Using electronic health networks to e-mail patients health	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic exchange of patient data for results from	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic exchange of patient data for admin data to	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic exchange of patient data for medical data to care providers / professionals	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic exchange of patient data for admin data to other	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
UPROV_Electronic exchange of patient data for prescription to	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
GPs using e-learning	29	Empirica (2007) Benchmarking ICT use among GP's in Europe	2007	random survey
USECIT_Lab test results communicated direct to patients via e-health	33	Survey Patient View for the Euro Health Consumer Index 2009	2009	patient survey
USECIT_Do patients have access to on-line booking of	33	Survey Patient View for the Euro Health Consumer Index 2009	2009	patient survey

Appendix II: Underlying variables from the factors in the macro model
Readiness

General conditions

RECONOMY_Grossnationalincomepercapita

Label component:	*Description:*
RECONOMY	Economic strength

Health care system (0,800)

Component >	I	II	III
RHEALTH_Physicians	0,900		
RHEALTH_Nursing and midwifery personnel	0,796		
RHEALTH_Dentistry personnel	0,701	0,492	
RHEALTH_Other health service providers		0,501	
RHEALTH_Hospital beds	0,823		
RHEALTH_Total exp on health vs GDP		0,824	
RHEALTH_General government exp on health vs total exp on health			0,955
RHEALTH_Private exp on health vs total exp on health			-0,955
RHEALTH_Government exp on health vs total government exp		0,756	0,463
RHEALTH_Per capita total exp on health (PPP int. $)_2006	0,536	0,636	

	Label component:	*Description:*
I	RHEALTH1	Health infrastructure
II	RHEALTH2	Health expenditures
III	RHEALTH3	Government control of health sector

National ICT policy (0,814)

	I	II	III	IV	V	VI	VII
RPOLICY_National information policy or strategy _policy				0,773			
RPOLICY_National ePolicy or eStrategy _policy	0,478			0,681			
RPOLICY_National eHealth policy or strategy _policy	0,786						
RPOLICY_Procurement policies or strategies_policy	0,565	0,421					
RPOLICY_Public funding_policy	0,528					0,422	
RPOLICY_Private funding_policy						0,722	
RPOLICY_Public-private partnerships_policy						0,776	
RPOLICY_eHealth standards_policy	0,763						
RPOLICY_Citizen protection_policy	0,592						
RPOLICY_Equity_policy	0,587						
RPOLICY_Cultural diversity_policy			0,678				
RPOLICY_National ICT in health development plan_policy	0,683				0,409		
RPOLICY_Policy on affordability of infrastructure_policy					0,715		
RPOLICY_Intersectoral and non-governmental cooperation_policy					0,697		
RPOLICY_Access to international electronic journals_policy		0,759					
RPOLICY_Access to national electronic journals_policy		0,795					
RPOLICY_National open archive_policy				0,407		0,400	
RPOLICY_Health information for the general public_policy		0,575					
RPOLICY_Multilingual projects_policy			0,832				
RPOLICY_Translation and cultural adaptation_policy			0,759				
RPOLICY_Training on ICT_policy				0,450	0,417		0,520
RPOLICY_Continuing education on ICT_policy		0,484					
RPOLICY_eLearning in health sciences_policy							0,772

	Label component:	*Description:*
I	RPOLICY1	eHealth policy
II	RPOLICY2	Access to information policy
III	RPOLICY3	Cultural diversity policy
IV	RPOLICY4	General ICT policy

dichotomous variables

RPOLICY5 >>> RPOLICY_National information policy or strategy _policy
RPOLICY6 >>> RPOLICY_National ePolicy or eStrategy _policy
RPOLICY7 >>> RPOLICY_Public funding_policy
RPOLICY8 >>> RPOLICY_Public-private partnerships_policy
RPOLICY9 >>> RPOLICY_Policy on affordability of infrastructure_policy
RPOLICY10 >>> RPOLICY_Intersectoral and non-governmental cooperation_policy
RPOLICY11 >>> RPOLICY_National open archive_policy
RPOLICY12 >>> RPOLICY_Training on ICT_policy
RPOLICY13 >>> RPOLICY_eLearning in health sciences_policy

Readiness (continued)

ICT infrastructure (0,763)

Component >	I
RICT_Internet subscribers	0,895
RICT_Internet users	0,887
RICT_Broadband subscribers	0,942
RICT_Use of internet in GP practices	0,876
RICT_Use of broadband in GP practices	0,953

Label component:	*Description:*
I RICT1	ICT infrastructure

Use

eHealth use by citizens (0,618)

Component >	I
	1,000
USECIT_Individuals using Internet to seek health information	0,799
USECIT_Lab test results communicated direct to patients via e-health solutions?	0,675
USECIT_Do patients have access to on-line booking of appointments?	0,837

Label component:	*Description:*
I USECIT1	Use of eHealth by citizens

eHealth use by professionals (0,717)

Component >	I	II	III	IV	V
UPROV_Use of electronic recording and storage of individual administrative patient data		0,921			
UPROV_Use of a computer during consultations		0,857			
UPROV_Use of DSS for diagnosis		0,937			
UPROV_Use of DSS for prescribing		0,799	0,422		
UPROV_Use of DSS for General advice		0,885			
UPROV_Use of DSS for Patient specific apps		0,741	0,430		
UPROV_Electronic connection between GP and other GPs	0,422	0,430	0,648		
UPROV_Electronic connection between GP and Hospitals		0,485	0,713		
UPROV_Electronic connection between GP and Specialist practices	0,489		0,692		
UPROV_Electronic connection between GP and Health authorities				0,728	
UPROV_Electronic connection between GP and insurance companies					0,902
UPROV_Electronic connection between GP and patients' homes	0,906				
UPROV_Electronic connection between GP and care homes	0,465		0,736		
UPROV_Electronic connection between GP and laboratories		0,559	0,639		
UPROV_Electronic connection between GP and pharmacies	0,808				
UPROV_Using electronic health networks to search medication information	0,427		0,744		
UPROV_Using electronic health networks to order practice supplies	0,645		0,430		
UPROV_Using electronic health networks to make appointments w/other care providers			0,846		
UPROV_Using electronic health networks to e-mail patients admin issues	0,905				
UPROV_Using electronic health networks to e-mail patients health issues	0,911				
UPROV_Electronic exchange of patient data for results from laboratories		0,533	0,640		
UPROV_Electronic exchange of patient data for admin data to reimbursers	0,440			0,598	0,447
UPROV_Electronic exchange of patient data for medical data to care providers / professionals	0,541		0,694		
UPROV_Electronic exchange of patient data for admin data to other care providers	0,723		0,455	0,407	
UPROV_Electronic exchange of patient data for prescription to pharmacies	0,855				

Label component:	*Description:*
I UPROV1	Using eHealth for B2C
II UPROV2	DSS use
III UPROV3	Using eHealth for B2B
IV UPROV4	Using eHealth to communicate with authorities
V UPROV5	Using eHealth to communicate with insurance

Impact

Effectiveness of health care system (0,634)

Component >	I	II
OPFACT_CAGR life expectancy at birth		0,844
OPFACT_Life expectancy at birth	0,974	
OPFACT_Healthy life expectancy at birth	0,975	
OPFACT_CAGR Under-5 mortality rate		-0,724
OPFACT_Under-5 mortality rate	-0,969	

Label component:	*Description:*
I OPFACT1	Long, healthy lives
II OPFACT2	Low child mortality

Efficiency of health care system (0,490)

Component >	I	II	III
OUTCOME_CAGR Total exp on health vs GDP		0,942	
OUTCOME_CAGR General government exp on health vs total exp on health	-0,981		
OUTCOME_CAGR Private exp on health vs total exp on health	0,972		
OUTCOME_CAGR Government exp on health vs total government exp		0,929	
OUTCOME_CAGR Per capita total exp on health (PPP int. $)_2000-2006			0,819
OUTCOME_Consumer prices of health			0,855

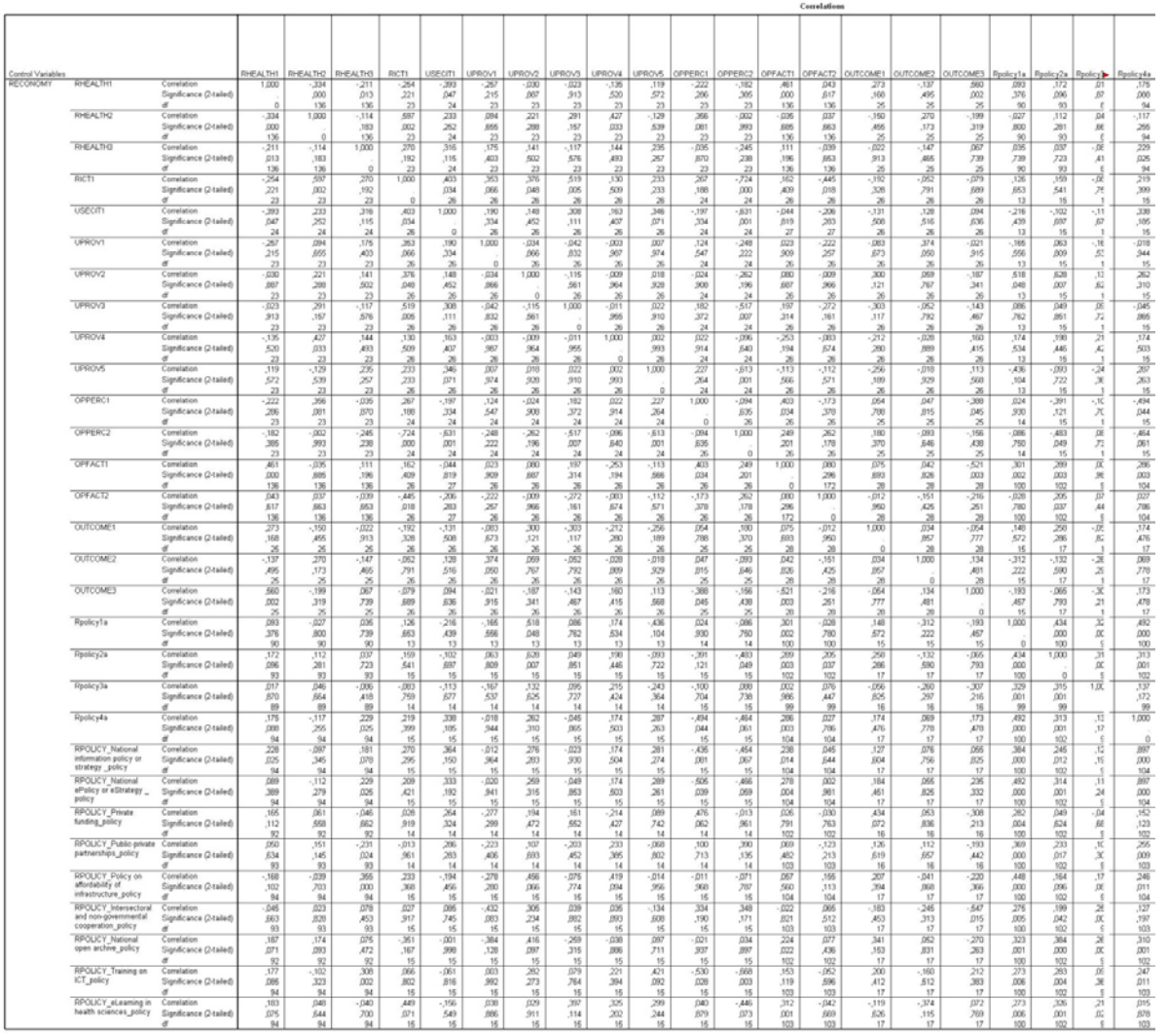
Label component:	*Description:*
I OUTCOME1	Growth in private expenditure on healthcare
II OUTCOME2	Growth in expenditure on healthcare related to GDP
III OUTCOME3	Growth in per capita expenditure on healthcare

Perceptions (0,657)

Component >	I	II
OPPERC_Perceived quality of GPs	0,775	
OPPERC_Being limited due to a limited physical or mental condition		0,814
OPPERC_Perceived quality of medical specialists	0,934	
OPPERC_Perceived quality of hospitals	0,917	
OPPERC_Doing a general check-up	-0,438	0,678

Label component:	*Description:*
I OPPERC1	Perception of healthcare
II OPPERC2	Perception of bad own health

Appendix III: Correlation matrix



Correlations

Control Variables			RHEALTH1	RHEALTH2	RHEALTH3	RICT1	USECIT1	UPROV1	UPROV2	UPROV3	UPROV4	UPROV5	OPPERC1	OPPERC2	OPFACT1	OPFACT2	OUTCOME1	OUTCOME2	OUTCOME3	Rpolicy1a	Rpolicy2a	Rpolicy3a	Rpolicy4a
RECONOMY	RHEALTH1	Correlation	1,000	,334	,211	,254	,393	,267	,030	,023	,136	,119	,222	,182	,461	,043	,273	,137	,860	,893	,172	,01	,176
		Significance (2-tailed)		,000	,376	,013	,221	,047	,215	,869	,513	,520	,572	,206	,395	,000	,617	,168	,495	,002	,376	,006	,97	,089
		df	0	136	136	23	24	23	23	23	23	23	23	23	136	136	25	25	25	90	93	6	94
	RHEALTH2	Correlation	,334	1,000	,114	,587	,233	,094	,221	,291	,427	,129	,366	,002	,035	,037	,150	,270	,199	,027	,112	,04	,117
		Significance (2-tailed)	,000		,183	,002	,252	,666	,288	,167	,033	,539	,081	,993	,685	,663	,466	,173	,319	,800	,281	,66	,256
		df	136	0	136	23	24	23	23	23	23	23	23	23	136	136	25	25	25	90	93	6	94
	RHEALTH3	Correlation	,211	,114	1,000	,270	,316	,175	,141	,117	,144	,235	,035	,245	,111	,039	,022	,147	,067	,035	,037	,08	,229
		Significance (2-tailed)	,013	,183		,192	,115	,403	,502	,576	,493	,267	,870	,238	,196	,653	,913	,486	,739	,739	,723	,41	,025
		df	136	136	0	23	24	23	23	23	23	23	23	23	136	136	25	25	25	90	93	6	94
	RICT1	Correlation	,254	,587	,270	1,000	,403	,353	,376	,519	,130	,233	,267	,724	,162	,445	,192	,052	,079	,126	,159	,08	,219
		Significance (2-tailed)	,221	,002	,192		,034	,066	,048	,005	,539	,233	,198	,000	,409	,018	,326	,791	,689	,663	,541	,75	,399
		df	23	23	23	0	26	26	26	26	26	26	24	24	26	26	26	26	26	13	15	1	15
	USECIT1	Correlation	,393	,233	,316	,403	1,000	,190	,148	,308	,163	,346	,197	,831	,044	,206	,131	,128	,094	,216	,102	,11	,338
		Significance (2-tailed)	,047	,252	,115	,034		,334	,452	,111	,407	,071	,334	,001	,819	,293	,506	,516	,636	,439	,697	,67	,195
		df	24	24	24	26	0	26	26	26	26	26	24	24	27	27	26	26	26	13	15	1	15
	UPROV1	Correlation	,267	,094	,175	,353	,190	1,000	,034	,042	,003	,007	,124	,248	,023	,222	,083	,374	,021	,165	,063	,18	,018
		Significance (2-tailed)	,215	,655	,403	,066	,334		,866	,832	,967	,974	,547	,222	,909	,257	,673	,050	,915	,556	,809	,52	,944
		df	23	23	23	26	26	0	26	26	26	26	24	24	26	26	26	26	26	13	15	1	15
	UPROV2	Correlation	,030	,221	,141	,376	,148	,034	1,000	,115	,039	,018	,024	,262	,080	,009	,300	,069	,187	,518	,628	,13	,262
		Significance (2-tailed)	,887	,288	,502	,048	,452	,866		,561	,864	,928	,908	,196	,687	,966	,121	,747	,341	,048	,007	,62	,310
		df	23	23	23	26	26	26	0	26	26	26	24	24	26	26	26	26	26	13	15	1	15
	UPROV3	Correlation	,023	,291	,117	,519	,308	,042	,115	1,000	,011	,022	,182	,517	,197	,272	,303	,052	,143	,086	,049	,05	,045
		Significance (2-tailed)	,913	,157	,576	,006	,111	,832	,561		,956	,910	,372	,007	,314	,161	,117	,792	,467	,762	,861	,72	,865
		df	23	23	23	26	26	26	26	0	26	26	24	24	26	26	26	26	26	13	15	1	15
	UPROV4	Correlation	,135	,427	,144	,130	,163	,003	,009	,011	1,000	,002	,022	,096	,253	,003	,212	,028	,160	,174	,190	,21	,174
		Significance (2-tailed)	,520	,033	,493	,529	,407	,987	,964	,955		,993	,914	,640	,194	,974	,280	,889	,415	,534	,446	,42	,503
		df	23	23	23	26	26	26	26	26	0	26	24	24	26	26	26	26	26	13	15	1	15
	UPROV5	Correlation	,119	,129	,235	,233	,346	,007	,018	,022	,002	1,000	,227	,873	,113	,112	,256	,018	,113	,436	,093	,24	,267
		Significance (2-tailed)	,572	,539	,257	,233	,071	,974	,928	,910	,993		,264	,001	,566	,571	,189	,929	,568	,104	,722	,38	,263
		df	23	23	23	26	26	26	26	26	26	0	24	24	26	26	26	26	26	13	15	1	15
	OPPERC1	Correlation	,222	,356	,035	,267	,197	,124	,024	,182	,022	,227	1,000	,094	,403	,173	,054	,047	,389	,024	,391	,10	,494
		Significance (2-tailed)	,286	,081	,870	,189	,334	,547	,908	,372	,914	,264		,635	,034	,378	,788	,815	,045	,930	,121	,70	,044
		df	23	23	23	26	24	24	24	24	24	24	0	26	26	26	26	26	26	14	15	1	15
	OPPERC2	Correlation	,182	,002	,245	,724	,631	,248	,262	,517	,096	,613	,094	1,000	,249	,262	,180	,093	,156	,086	,483	,08	,464
		Significance (2-tailed)	,389	,993	,238	,000	,001	,222	,196	,007	,640	,001	,635		,201	,178	,370	,646	,438	,760	,049	,72	,061
		df	23	23	23	24	24	24	24	24	24	24	26	0	26	26	25	25	25	14	15	1	15
	OPFACT1	Correlation	,461	,035	,111	,162	,044	,023	,080	,197	,253	,113	,403	,249	1,000	,080	,075	,042	,521	,301	,299	,00	,286
		Significance (2-tailed)	,000	,685	,196	,409	,819	,909	,687	,314	,194	,566	,034	,201		,296	,693	,826	,003	,002	,003	,98	,003
		df	136	136	136	26	27	26	26	26	26	26	26	26	0	172	28	28	28	100	102	5	104
	OPFACT2	Correlation	,043	,037	,039	,445	,206	,222	,009	,272	,003	,112	,173	,262	,080	1,000	,012	,151	,216	,028	,205	,07	,027
		Significance (2-tailed)	,617	,663	,653	,018	,283	,267	,966	,161	,974	,571	,378	,178	,296		,950	,426	,251	,780	,037	,44	,786
		df	136	136	136	26	27	26	26	26	26	26	26	26	172	0	28	28	28	100	102	5	104
	OUTCOME1	Correlation	,273	,150	,022	,192	,131	,083	,300	,303	,212	,256	,054	,100	,075	,012	1,000	,034	,054	,148	,258	,05	,174
		Significance (2-tailed)	,168	,455	,913	,328	,508	,673	,121	,117	,280	,189	,788	,370	,693	,950		,857	,777	,572	,296	,82	,476
		df	25	25	25	26	26	26	26	26	26	26	25	25	28	28	0	28	28	15	17	1	17
	OUTCOME2	Correlation	,137	,270	,147	,052	,128	,374	,069	,052	,028	,018	,047	,093	,042	,151	,034	1,000	,134	,312	,132	,26	,069
		Significance (2-tailed)	,495	,173	,495	,791	,516	,050	,767	,792	,889	,929	,815	,646	,826	,425	,857		,491	,222	,590	,25	,778
		df	25	25	25	26	26	26	26	26	26	26	25	25	28	28	28	0	28	15	17	1	17
	OUTCOME3	Correlation	,560	,199	,067	,079	,094	,021	,187	,143	,160	,113	,388	,156	,521	,216	,064	,134	1,000	,193	,065	,32	,173
		Significance (2-tailed)	,002	,319	,739	,689	,636	,916	,341	,467	,416	,568	,045	,438	,003	,261	,777	,491		,467	,793	,21	,478
		df	25	25	25	26	26	26	26	26	26	26	25	25	28	28	28	28	0	15	17	1	17
	Rpolicy1a	Correlation	,093	,027	,035	,126	,216	,165	,518	,086	,174	,436	,024	,086	,301	,028	,148	,312	,193	1,000	,434	,32	,492
		Significance (2-tailed)	,376	,800	,739	,663	,439	,566	,048	,762	,534	,104	,930	,750	,002	,780	,572	,222	,467		,000	,00	,000
		df	90	90	90	13	13	13	13	13	13	13	14	14	100	100	15	15	15	0	100	5	100
	Rpolicy2a	Correlation	,172	,112	,037	,159	,102	,063	,026	,049	,190	,093	,391	,403	,099	,205	,259	,132	,065	,434	1,000	,31	,313
		Significance (2-tailed)	,096	,281	,723	,541	,697	,809	,907	,851	,446	,722	,121	,049	,003	,037	,286	,590	,793	,000		,00	,001
		df	93	93	93	15	15	15	15	15	15	15	15	15	102	102	17	17	17	100	0	5	102
	Rpolicy3a	Correlation	,017	,046	,006	,093	,113	,167	,132	,095	,215	,243	,100	,000	,002	,076	,056	,260	,307	,329	,315	1,00	,137
		Significance (2-tailed)	,870	,664	,418	,759	,677	,537	,625	,727	,424	,364	,704	,738	,986	,447	,625	,297	,216	,001	,001		,172
		df	89	89	89	14	14	14	14	14	14	14	15	15	99	99	16	16	16	99	99		99
	Rpolicy4a	Correlation	,176	,117	,229	,219	,338	,018	,262	,045	,174	,287	,494	,464	,286	,027	,174	,089	,173	,492	,313	,13	1,000
		Significance (2-tailed)	,089	,255	,025	,399	,105	,944	,310	,665	,503	,263	,044	,061	,003	,786	,476	,778	,479	,000	,001	,12	
		df	94	94	94	15	15	15	15	15	15	15	15	15	104	104	17	17	17	100	102	5	0
	RPOLICY_National information policy or strategy _policy	Correlation	,228	,087	,181	,270	,364	,012	,276	,023	,174	,281	,436	,464	,236	,045	,127	,076	,055	,384	,246	,12	,897
		Significance (2-tailed)	,025	,345	,078	,295	,150	,964	,283	,930	,504	,274	,081	,067	,014	,644	,604	,756	,825	,000	,012	,15	,000
		df	94	94	94	15	15	15	15	15	15	15	15	15	104	104	17	17	17	100	102	5	104
	RPOLICY_National ePolicy or eStrategy _ policy	Correlation	,089	,112	,229	,209	,333	,020	,269	,049	,174	,289	,505	,466	,278	,002	,184	,056	,235	,492	,314	,11	,897
		Significance (2-tailed)	,389	,279	,026	,421	,192	,941	,316	,863	,503	,261	,039	,069	,004	,981	,481	,826	,332	,000	,001	,24	,000
		df	94	94	94	15	15	15	15	15	15	15	15	15	104	104	17	17	17	100	102	5	104
	RPOLICY_Private funding_policy	Correlation	,165	,061	,046	,038	,264	,277	,194	,161	,214	,089	,476	,013	,026	,030	,434	,053	,308	,262	,049	,04	,152
		Significance (2-tailed)	,112	,558	,662	,919	,324	,299	,472	,552	,427	,742	,062	,961	,791	,763	,072	,836	,213	,004	,624	,68	,123
		df	92	92	92	14	14	14	14	14	14	14	14	14	102	102	16	16	16	100	102	5	102
	RPOLICY_Public-private partnerships_policy	Correlation	,060	,151	,231	,013	,286	,223	,107	,203	,233	,068	,100	,090	,009	,123	,126	,112	,193	,369	,233	,10	,255
		Significance (2-tailed)	,634	,145	,024	,961	,283	,406	,693	,452	,395	,802	,713	,395	,482	,213	,619	,657	,442	,000	,017	,30	,009
		df	93	93	93	14	14	14	14	14	14	14	14	14	103	103	16	16	16	100	102	5	103
	RPOLICY_Policy on affordability of infrastructure_policy	Correlation	,168	,039	,355	,233	,194	,278	,456	,076	,419	,014	,011	,071	,057	,165	,207	,041	,220	,448	,164	,17	,246
		Significance (2-tailed)	,102	,703	,000	,368	,456	,280	,066	,774	,094	,956	,960	,787	,560	,113	,394	,868	,396	,000	,096	,08	,011
		df	94	94	94	15	15	15	15	15	15	15	15	15	104	104	17	17	17	100	102	5	104
	RPOLICY_Intersectoral and non-governmental cooperation_policy	Correlation	,046	,023	,078	,027	,095	,432	,305	,039	,036	,134	,334	,348	,022	,065	,183	,246	,547	,275	,199	,28	,127
		Significance (2-tailed)	,663	,826	,453	,917	,745	,083	,234	,882	,893	,608	,190	,171	,821	,512	,453	,313	,015	,005	,042	,00	,197
		df	93	93	93	15	15	15	15	15	15	15	15	15	103	103	17	17	17	100	102	5	103
	RPOLICY_National open archive_policy	Correlation	,187	,174	,075	,351	,001	,384	,416	,268	,038	,097	,021	,034	,224	,077	,341	,052	,270	,323	,384	,28	,310
		Significance (2-tailed)	,071	,093	,472	,167	,998	,128	,097	,315	,886	,711	,937	,897	,022	,436	,183	,831	,263	,001	,000	,00	,001
		df	92	92	92	15	15	15	15	15	15	15	15	15	102	102	17	17	17	100	102	5	102
	RPOLICY_Training on ICT_policy	Correlation	,177	,102	,308	,066	,061	,003	,262	,079	,221	,421	,530	,668	,153	,052	,200	,160	,212	,273	,263	,05	,247
		Significance (2-tailed)	,088	,323	,002	,802	,818	,992	,273	,764	,394	,082	,028	,003	,119	,596	,412	,512	,383	,006	,004	,36	,011
		df	94	94	94	15	15	15	15	15	15	15	15	15	103	103	17	17	17	100	102	5	103
	RPOLICY_eLearning in health sciences_policy	Correlation	,183	,048	,040	,449	,156	,030	,029	,397	,325	,299	,040	,446	,312	,042	,119	,374	,072	,273	,326	,21	,015
		Significance (2-tailed)	,075	,644	,700	,071	,549	,886	,911	,114	,202	,244	,879	,073	,001	,869	,626	,115	,769	,006	,001	,02	,878
		df	94	94	94	15	15	15	15	15	15	15	15	15	103	103	17	17	17	100	102	5	103

Appendix IV: Countries used in the dataset

The average of this set of countries is used as the average score in the radar charts. The actual number of countries used in the correlation may differ slightly from one variable to another (see Appendix V)

Country
Australia
Austria
Belgium
Canada*
Czech Republic
Denmark*
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Italy
Japan
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Republic of Korea
Slovakia
Spain*
Sweden
Switzerland
Turkey
United Kingdom
United States of America

Appendix V: Number of cases (countries) for each of the variables

Individual variables

N	*Number of cases (countries)*
(30)	OPFACT_CAGRlifeexpectancyatbirth
(30)	OPFACT_Lifeexpectancyatbirth
(30)	OPFACT_Healthylifeexpectancyatbirth
(30)	Neonatalmortalityrate
(30)	infantmortalityrate
(30)	Infantmortalityrate_A
(30)	OPFACT_CAGRUnder5mortalityrate
(30)	OPFACT_Under5mortalityrate
(30)	Maternalmortalityratio
(20)	Birthsattendedbyskilledhealthpersonnel
(30)	RHEALTH_Physicians
(30)	RHEALTH_Nursingandmidwiferypersonnel
(30)	RHEALTH_Dentistrypersonnel
(29)	RHEALTH_Otherhealthserviceproviders
(28)	RHEALTH_Hospitalbeds
(30)	OUTCOME_CAGRTotalexponhealthvsGDP
(30)	RHEALTH_TotalexponhealthvsGDP
(30)	OUTCOME_CAGRGeneralgovernmentexponhealthvstotalexponhe
(30)	RHEALTH_Generalgovernmentexponhealthvstotalexponhealth
(30)	OUTCOME_CAGRPrivateexponhealthvstotalexponhealth
(30)	RHEALTH_Privateexponhealthvstotalexponhealth
(30)	OUTCOME_CAGRGovernmentexponhealthvstotalgovernmentexp
(30)	RHEALTH_Governmentexponhealthvstotalgovernmentexp
(30)	OUTCOME_CAGRPercapitatotalexponhealthPPPint.$_200020
(30)	RHEALTH_PercapitatotalexponhealthPPPint.$_2006
(30)	CAGRGrossnationalincomepercapita
(30)	RECONOMY_Grossnationalincomepercapita
(20)	RPOLICY_Nationalinformationpolicyorstrategy_policy
(20)	RPOLICY_NationalePolicyoreStrategy_policy
(20)	RPOLICY_NationaleHealthpolicyorstrategy_policy
(19)	RPOLICY_Procurementpoliciesorstrategies_policy
(19)	RPOLICY_Publicfunding_policy
(18)	RPOLICY_Privatefunding_policy
(19)	RPOLICY_Publicprivatepartnerships_policy
(20)	RPOLICY_eHealthstandards_policy
(20)	RPOLICY_Citizenprotection_policy
(20)	RPOLICY_Equity_policy
(20)	RPOLICY_Culturaldiversity_policy
(20)	RPOLICY_NationalICTinhealthdevelopmentplan_policy
(20)	RPOLICY_Policyonaffordabilityofinfrastructure_policy
(20)	RPOLICY_Intersectoralandnongovernmentalcooperation_policy
(20)	RPOLICY_Accesstointernationalelectronicjournals_policy
(20)	RPOLICY_Accesstonationalelectronicjournals_policy
(20)	RPOLICY_Nationalopenarchive_policy
(20)	RPOLICY_Healthinformationforthegeneralpublic_policy
(19)	RPOLICY_Multilingualprojects_policy
(19)	RPOLICY_Translationandculturaladaptation_policy
(20)	RPOLICY_TrainingonICT_policy
(20)	RPOLICY_ContinuingeducationonICT_policy

Individual variables (continued)

N	*Number of cases (countries)*
(20)	RPOLICY_eLearninginhealthsciences_policy
(29)	RICT_Internetsubscribers
(30)	RICT_Internetusers
(30)	RICT_Broadbandsubscribers
(23)	Individuals using Internet to seek health information
(23)	OUTCOME_Consumerpricesofhealth
(20)	OPPERC_PerceivedqualityofGPs
(20)	OPPERC_Beinglimitedduetoalimitedphysicalormentalconditi
(20)	OPPERC_Perceivedqualityofmedicalspecialists
(20)	OPPERC_Perceivedqualityofhospitals
(20)	OPPERC_Doingageneralcheckup
(21)	UseofcomputersinGPpractices
(21)	RICT_UseofinternetinGPpractices
(21)	RICT_UseofbroadbandinGPpractices
(21)	UPROV_Useofelectronicrecordingandstorageofindividualadmi
(21)	UPROV_Useofacomputerduringconsultations
(21)	UPROV_UseofDSSfordiagnosis
(21)	UPROV_UseofDSSforprescribing
(21)	UPROV_UseofDSSforGeneraladvice
(21)	UPROV_UseofDSSforPatientspecificapps
(21)	UPROV_ElectronicconnectionbetweenGPandotherGPs
(21)	UPROV_ElectronicconnectionbetweenGPandHospitals
(21)	UPROV_ElectronicconnectionbetweenGPandSpecialistpractices
(21)	UPROV_ElectronicconnectionbetweenGPandHealthauthorities
(21)	UPROV_ElectronicconnectionbetweenGPandinsurancecompanies
(21)	UPROV_ElectronicconnectionbetweenGPandpatients'homes
(21)	UPROV_ElectronicconnectionbetweenGPandcarehomes
(21)	UPROV_ElectronicconnectionbetweenGPandlaboratories
(21)	UPROV_ElectronicconnectionbetweenGPandpharmacies
(21)	UPROV_Usingelectronichealthnetworkstosearchmedicationinfo
(21)	UPROV_Usingelectronichealthnetworkstoorderpracticesupplie
(21)	UPROV_Usingelectronichealthnetworkstomakeappointmentswot
(21)	UPROV_Usingelectronichealthnetworkstoemailpatientsadmin
(21)	UPROV_Usingelectronichealthnetworkstoemailpatientshealth
(21)	UPROV_Electronicexchangeofpatientdataforresultsfromlabor
(21)	UPROV_Electronicexchangeofpatientdataforadmindatatoreim
(21)	UPROV_Electronicexchangeofpatientdataformedicaldatatoca
(21)	UPROV_Electronicexchangeofpatientdataforadmindatatoothe
(21)	UPROV_Electronicexchangeofpatientdataforprescriptiontoph
(21)	GPsusingelearning
(22)	USECIT_Labtestresultscommunicateddirecttopatientsviaehe
(22)	USECIT_Dopatientshaveaccesstoonlinebookingofappointment

Components

N	*Number of cases (countries)*
(27)	RHEALTH1
(27)	RHEALTH2
(27)	RHEALTH3
(30)	GNI / cap
(21)	RICT1
(16)	RPOLICY1
(16)	RPOLICY2
(16)	RPOLICY3
(16)	RPOLICY4
(16)	RPOLICY5
(16)	RPOLICY6
(16)	RPOLICY7
(21)	USECIT1
(21)	UPROV1
(21)	UPROV2
(21)	UPROV3
(21)	UPROV4
(21)	UPROV5
(20)	OPPERC1
(20)	OPPERC2
(30)	OPFACT1
(30)	OPFACT2
(23)	OUTCOME1
(23)	OUTCOME2
(23)	OUTCOME3
(18)	Rpolicy1a
(20)	Rpolicy2a
(19)	Rpolicy3a
(20)	Rpolicy4a