Prospects for Telemedicine Adoption:
Prognostic Modeling as Exemplified by Rural Areas of USA

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Abstract

Experts predict that in the majority of countries state healthcare expenditures will continue to rise. Usage of telemedicine applications — the use of information and communications technologies (ICT) in order to provide clinical health care at a distance — will help optimize the costs of healthcare in the long-term.

The main advantages of telemedicine include reducing the number of doctor's errors, saving both patients and physicians time, and improving the efficiency of healthcare organizations. It also ensures timely and high-quality services for large segments of the population living in remote territories with difficult socio-economic conditions, particularly rural areas.

The paper forecasts the adoption rate of telemedicine in US rural areas by using the Bass Model. The model is considered quite versatile as it can be used across a wide range of products and services. Nevertheless, the Bass model has some limitations related to how it estimates missing data. Calculation errors can be related to numerous barriers, which affect the adoption rate of telemedicine. These barriers include: high costs of production and exploitation of hi-tech equipment; physicians insufficiently prepared to adopt and use the latest technologies in their daily work; as well as possible concerns of patients about the quality of remote healthcare service.

Keywords: telemedicine; remote areas; remote medical services; information and communication technologies (ICT); healthcare expenditures; the Bass model

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Healthcare is one of the most important sectors in any country for two main reasons. First, this is because it is related to people's health and their lives. Second, because medical care costs are high in both developed and developing countries. According to the Centers for Medicare and Medicaid Services, Office of the Actuary, National Health Statistics Group; the US Department of Commerce, Bureau of Economic Analysis; and the US Bureau of the Census, in the US, national health spending in 2011 was just over USD2,700bn. This was about 17.9% of the country's Gross Domestic Product (GDP), which was USD15,076bn [CMS, 2012].

US national expenditures on health is expected to rise. According to the Center for Medicare and Medicaid Services, it will reach USD4,638bn by the end of 2020, comprising about 20% of US GDP (will be USD17,775bn) by the same year [*Ibid.*]. Therefore, we need healthcare to take advantage of Telemedicine applications that reduce the cost of healthcare in the long-term. In addition, Telemedicine helps reduce doctor errors, and saves time for both patients and physicians. The US population has been annually increasing; during the last decade, it increased from 282 million in 2000 to 311 million in 2011, which is an increase of more than 9%. Meanwhile, healthcare expenditures increased almost double in the last 30 years, from 9.2% in 1980 to 17.9% in 2011. These data are plotted in Figure 1 below.

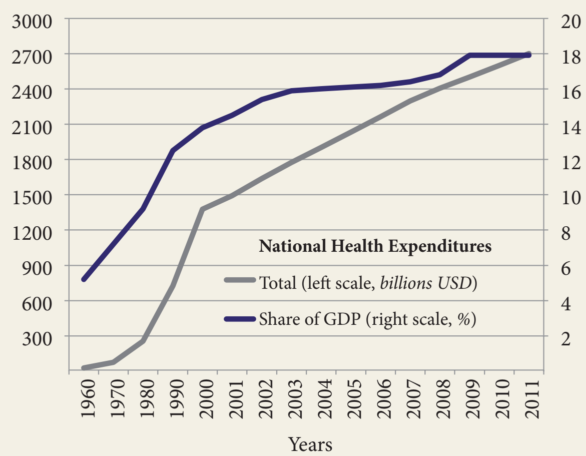
History and Background of Telemedicine

Distance healthcare services have been in vogue for centuries, with healers using available resources to communicate with patients. For example, postal mail was one of the first tools of communication that was used followed by the telegraph, first used during the American Civil War [*Craig, Patterson,* 2005]. Soon the radio was used in healthcare for long distance international communication [*Stanberry,* 2000].

In 1924, science recorded one of the first conceptions of telediagnostic and televisit where a distance diagnostic examination of children was conducted using direct imaging [*Ramos,* 2010]. During the 1920s, Telemedicine was very useful, where physicians at the coast station assisted ships with medical emergencies in the middle of the ocean by using radios. Further, in April 1924, the 'Radio News' magazine included an article about telecare and put it on its cover page [*Ibid.*]. We can summarize the phases of telemedicine developments as shown below in Table 1.

Telemedicine introduced as an implementation tool to improve and support healthcare services will cause huge changes in healthcare organization [*Hu,* 2000]. The impact of telemedicine will reach all levels of healthcare organization from physicians and nurses to the bottom level. Physicians play a primary role for telemedicine users and their decision to adopt a new technology is the first step for the emergence and sustainability of telemedicine networks [*Cagnon et al.,* 2003; *Croteau, Vieru,* 2002].

Fig. 1. **The percentage of gross domestic product (GDP) on national health expenditure, and total national health expenditure, 1960–2011**



Source: [CMS, 2012].

Table 1. **Phases of Telemedicine development**

Time Scale	Technology used	Examples/Description
Mid-19th century	Postal	Prescriptions and diagnosis exchanged between patient and physician by post.
1835	Telegraphy	Used during American Civil War to send casualty lists and order supplies
1906	Telephone	Electrocardiograms sent using telephone networks
1920	Radio	Seaman's Church Institute of New York — first organization to provide medical care using radio
1950s onwards	Television and Space Technologies	Two way closed circuit television correspondence between Nebraska Psychiatric Institute and Mental Hospital in Norfolk
1967	Video conferencing	Station established at Massachusetts General Hospital/ Logan International Airport to provide emergency medical care to airport employees and travellers
1990s onwards	Internet	Used in remote patient monitoring, store and forward modes using web for data transfer
2000s onwards	Mobile phones and Satellite communication	Web-enabled mobile devices are used to transmit patient information from moving ambulances to hospitals

Source: [*Makena, Hayes*, 2011].

As the practice of medicine has become more complex, it is increasingly difficult for physicians to provide the right care to patients every time without the support of modern health information technology. Like any modern endeavour, healthcare demands that the right information about the right person to be delivered to the right place and time. Evidence suggests that the use of information technology (IT) offers the industry tremendous potential for resolving some of its most important issues, specifically the rising number of medical errors, escalating costs, and care fragmentation [*Kuperman, Gibson*, 2003].

To improve the quality of medicine and minimize the possibility of adverse outcomes, healthcare places great hope in the potential of Health Information Technology (HIT). HIT in general and electronic health records (EHRs) in particular are viewed as tools to reduce medical errors, improve healthcare quality, and streamline operational efficiencies [*Frist*, 2005]. Moreover, it is considered foundational to the transformation of the US health system.

Such systems will support clinical decisions, grant patients and clinicians access to health records, improve the accuracy of those records, seamlessly integrate clinical and payment functions, and facilitate the collection, reporting, and analysis of quality data. In healthcare, the ultimate goal is to employ IT so that providers can ensure patients receive the highest quality of care and best outcomes [*DePhillips*, 2007]. IT can also enable the healthcare system to improve operational efficiencies and reduce costs.

A study done by the Agency for Healthcare Research and Quality (AHRQ) indicates that telemedicine is a small but growing movement and concluded that 'active programs demonstrate that the technology can work, and their growing number indicates that telemedicine can be used beneficially from clinical and economic standpoints' [*Trembly*, 2001].

After reviewing the literature the same study identified 455 telemedicine programmes, and about 80% of which are in the US. The top three common telemedicine activities for these programmes were consultations or second opinions (290 programs), diagnostic test interpretation (169 programs), and chronic disease management (130 programs) [*Casalino et al.*, 2003].

The doption of health information technology and systems for sharing information across providers has been slow, varying across practices and countries [*Ibid.*]. Traditionally, health IT (HIT) adoption has been slow because the industry itself is vastly different from most others. Further, it spends about 50% less on IT than most other sectors [*Bates*, 2002].

More than 40% of information technology (IT) developments in various sectors including the health sector have failed or been abandoned. One of the major factors leading to failure is inadequate understanding of the socio-technical aspects of IT, particularly the understanding of how people and organizations adopt information technology [*Kijsanayotin et al.*, 2009]. A recent literature review suggests that EHR adoption rates in the US are still quite low [*Jha et al.*, 2006]. Moreover, a survey by the Commonwealth Fund (CMWF) about how EHR is used by primary care physicians found that the US lags far behind many other industrialized nations in HIT use in ambulatory care [*Schoen et al.,* 2006].

The government has made this issue a priority. The Obama Administration's national coordinator for health information technology (HIT) David Blumenthal, MD, MPP has said: 'Nothing could be more important than how we manage health information', and '"Information is the lifeblood of medical practice. It truly sustains and supports practice, and makes it possible for practice to occur in a science-based way' [NQF, 2010].

Definitions and Categories of Telemedicine

The definition of telemedicine is different from organization to organization and varies between industry and academic perspectives. Thus there are many definitions and categories of Telemedicine depending on the background and the perspective. According to the American Medical Association (AMA) the definitions of 'telemedicine' have developed over time starting from a wide definition to a narrower one [*Tan et al.,* 2002].

The World Health Organization (WHO) defines telemedicine as 'The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities'. [WHO, 2010] According to The European Commission (EC), 'Telemedicine is the rapid access to shared and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or the relevant information is located.'[EHTEL, 2008]

The American Telemedicine Association (ATA) defines telemedicine as 'The use of medical information exchanged from one site to another via electronic communications to improve patients' health status' [ATA, 2015]. From the three different definitions of Telemedicine, we may conclude that there are three defining factors of Telemedicine: improvement of quality of healthcare, use of information technology, and distance.

Just as its definition differs between organizations and sectors, the categories of telemedicine also vary depending on the background and perspectives of any given theoretical or empirical study.

According to the World Health Organization (WHO), based on the time of the information transmitted and the interaction between patient and health professional, telemedicine can be classified into two basic types: store-and-forward (asynchronous) and real time (synchronous) [*Craig, Patterson,* 2005; WHO, 2010]. Another classification by the American Telemedicine Association (ATA) classified telemedicine services into five main categories: specialist referral services, patient consultations, remote patient monitoring, medical education, and consumer medical and health information [ATA, 2015].

After reviewing many pieces of literature on the categorization and classification of telemedicine, we decided to group all these categories and classifications into three main categories: Real Time (Synchronous), Store-And-Forward (Asynchronous), and Remote Monitoring.

Real Time (Synchronous)

When the patient and physician are located in two different locations at the same time and by using interactive videoconference equipment, they can interact as they do in traditional face-to-face practice [*Rao, Lombardi,* 2009] it falls under the category 'Real Time telemedicine.' This may include phone conversations, online communication, and home visits.

Some devices connected to the computer enable physicians to get more information about their patients such as hearing the patient's heartbeat with the use of a stethoscope. Specialized fields such as psychiatry, internal medicine, rehabilitation, cardiology, pediatrics, obstetrics, gynaecology, and neurology have benefited enormously from this practice.

Store-And-Forward (Asynchronous)

In this category, both the patient and the health specialist are located in two different times and locations. Store-and-forward telemedicine involves acquiring medical data (text, data, images, audio, biosignals, etc.) from the patient and then transmitting this data to a doctor or medical specialist at an appropriate time to be evaluated by a specialist at another time and location.

This category requires a good medical record system with a flexible and secure method of receiving and transferring medical information such as x-ray and digital photography. The top three specialized fields that widely use this type of store-and-forward consultation are dermatology, radiology, and pathology.

A good example of store-and-forward consultation is x-rays where a provider at a remote site typically takes x-rays of the patient and then uploads those images to a secure server along with other clinical information. Afterwards, a specialist at another time and location logs in, reviews both the x-rays and the clinical information, and writes his/her treatment recommendations [*Makena, Hayes*, 2011].

Remote Monitoring

Remote patient monitoring enables medical professionals to monitor a patient by remotely using various technological devices. Remote patient monitoring uses devices to remotely collect and send data to a health agency or a remote diagnostic testing facility (RDTF) for interpretation. Such applications might include a specific vital sign, such as heart disease, diabetes mellitus, asthma, or a variety of indicators for homebound patients [ATA, 2015]. According to Field and Grigsby, 'the continuing improvements in technology have made home monitoring applications more clinically useful and easier for patients to use without onsite help from healthcare personnel' [*Field, Grigsby*, 2002].

Advantages of Telemedicine

Telemedicine has many advantages for patients and providers, as well as the economy. Demand for telemedicine has continued to increase among patients and providers. Patients like telemedicine for two main reasons — it saves time and is convenient. Providers, on their part, prefer telemedicine as it facilitates better monitoring and early treatment. In general, this will improve the healthcare system and reduce the cost of the treatment. We will talk in some detail about each of these three aspects of the telemedicine system: patients, providers and economics.

Patients

The benefits of using telemedicine among patients relate to time, money, and quality. The traditional healthcare system requires patients to travel physically from, say, their rural home to metropolitan areas in order to consult a medical specialist. By using telemedicine, patients can consult a city doctor or the rural primary care provider from their home. As we know the United States has large rural and suburban areas, and telemedicine works to save millions in travel expenses.

Moreover, quality is one of the biggest advantages of telemedicine, as patients in rural areas can access high quality healthcare services. Telemedicine aims to improve healthcare quality by increasing collaboration between providers and patients.

Providers

With the help of telemedicine, providers can gain benefits such as access to information, decreased medical errors, and increased work efficiency. In business, time is money, but in the Emergency Room, time is life. Telemedicine provides immediate access to information for patients and on medical topics that is fast and accurate at the same time.

In addition, telemedicine will improve the accuracy of diagnosis, which would reduce medical errors, an important consideration for the medical community. One of the advantages of this system is 'tele-assistance', where a physician can get either a second or specialist opinion on their patients' diagnosis. Correct diagnosis the very first time has many benefits for both patients and hospitals, as it reduces the average recovery time and the use of unnecessary medicines. This ultimately reduces the costs borne by both patients and hospitals.

Continual education is very important in any field, and is essential in healthcare. Telemedicine can enhance the providers' learning and keep them up to date about any medical topic. Physicians can improve their education with the latest knowledge without leaving their office, thus saving providers time and money.

Economy

The economy will benefit from telemedicine as it will enhance the local economy and increase business retention and recruitment. Telemedicine can also improve the healthcare services' delivery system. New telemedicine technologies increase home health providers' efficiency by reducing travel time to patients' homes. In addition, patients have a greater chance of consultation with specialists by dint of new telemedicine technologies.

Furthermore, some people in rural areas cannot travel outside the community for training or studying. Telemedicine can provide high quality healthcare education and training partnership with educational institutions with the use of videoconferencing tools in rural communities. This will help cover the shortage of medical staff in rural hospitals by hiring more local people. To sum up, telemedicine provides quality healthcare services for people in rural areas, as well as improves the quality of healthcare services in both metropolitan and rural areas.

Telemedicine in Rural Areas

According to a recent study by Dr. Alexander Vo of the University of Texas Medical Branch, one of the biggest challenges facing the US healthcare system is the provision of quality care to large segments of the population who do not have access to specialized physicians. These areas are often isolated due to geographical limitations or socio-economic conditions. Dr. Vo supports the various benefits that telemedicine brings to rural areas. One of the positive benefits of building high-speed networks is that they allow for real-time monitoring and interactions with patients without requiring their physical presence at a care center.

He argues, 'The use of technology to deliver healthcare from a distance, or telemedicine, has been demonstrated as an effective way of overcoming certain barriers to care, particularly for communities located in rural and remote areas.' He also asserts, 'telemedicine can ease the gaps in providing crucial care for those who are underserved, principally because of a shortage of sub-specialty providers.' [*Vo et al.*, 2011]

According to the 2010 US Census, about three out of ten Americans live in a rural area or a very small city; and 28.8% of Americans reside in a rural area or city of between 2,500 and 50,000 residents. The population living in rural or unincorporated areas totalled 59.5 million in 2010, or 9.5% of the population.

In 15 US states, more than half of the population lives in rural areas or in towns with less than 50,000 inhabitants. The most rural state is Vermont, with 82.6% of its population in either rural areas or small cities. 55.5% of Alaska's population lives in rural areas or small towns, whereas Hawaii has the national average (28.5% of its population in rural areas or small towns).

The objective of this paper is to forecast the adoption rate of telemedicine in a country's rural areas by using the Bass Model, using data from the US as an illustration. An advantage of the Bass model is that it can be employed even when there are no data about the phenomenon being studied. The data used in this model are based on data of other products, which have already been introduced in the market. Then, the data about existing products or technologies are related to this new product.

Bass model

Before introducing the Bass model equation, let us define some important terms:

- $N(t)$ is the total or cumulative number of consumers who have already adopted the new product through period t
- $N(t-1)$ is the cumulative number of adopters for the new product through the previous time period (i.e., $t-1$)
- $S(t)$ is the number of new adopters for the product *during* the time period t and can be expressed as $N(t) - N(t-1)$

where N is the total number of consumers who have already adopted the new product through period t. There are three key parameters in the Bass model *m, p, and q*, where m is the market size, p the coefficient of innovation, and q the coefficient of imitation.

The basic equation for the Bass model:

$p + (q/m)\ N\ (t-1)$

The likelihood of purchase by a new adopter in time period *t.*

$m - N\ (t-1)$

Is the number of consumers who have *not* previously adopted the new product by the start of time period *t*; this is the pool from which new adoptions in the current period can occur.

In its simplest form, the Bass model looks as follows:

$S\ (t) = [p + (q/m)\ N(t-1)]\ [m - N(t-1)]$

Where $S\ (t)$ — the number of new adopters during time *t*.

However, the estimated data cause errors of forecasting in this model. Hence, the Bass model is developed into a generalized Bass model by adding the price of the new product into the model in order to identify the likely adoption of new products when promotions and prices influence the market.

The number of new adopters during time *t:*

$S(t) = [p + (q/m)\ N(t-1)]\ [m - N(t-1)]\ Z(t)$

Where $Z(t) = 1 + \text{a}\ [P(t) - P(t-1)]\ P(t-1)$

The Bass model can represent distinctly different patterns of adoption — from slow growth to instant hits. Different products include state-of-the-art consumer electronics to such common tools as the toaster and the hair dryer. Distinctly different fields include those medical breakthroughs such as artificial insemination and rural innovation [*Bass et al.,* 1994]. Bass model is a predictive model that allows us to forecast future adoptions, even when no data exist for our innovation.

We can use the parameters from the database of products that had similar characteristics when they were adopted. The model was developed for predicting sales of durable goods such as stoves, refrigerators, dishwashers, and air conditioners. These are products that, after initial adoption, are not repurchased for many years. This enabled a simple representation of the adoption process that has proven to be very robust. It works well because the assumptions in the Bass model are based on the results of diffusion research [*Bass et al.,* 1994; *Bass,* 2004]. The model has been used across a wide range of product and service categories.

However, the Bass model can still make errors and project uncertainties due to its method of estimating and assuming unknown data. Thus, before selecting the forecasting method, forecasters should choose the method most appropriate for their data [*Ofek,* 2006].

Estimating the Parameters *m*, *p*, and *q*

Estimating *m* (Market Potential)

It is best to estimate *M* independent of the model. In most cases, the management has a judgment and a strong intuitive feel about the size of the market, although it may be optimistic. If not, this estimate can often be obtained from analyst forecasts, marketing research, or can be calibrated by testing the logic and assumption behind the estimate (e.g. using the Delphi Method). Pharmaceutical firms, for example, often have rather precise estimates of the incidence of a disease or ailment. It is often worthwhile to obtain an independent third party estimate to calibrate and minimize the risk of bias and group think [*Bass,* 2004; *Norton, Bass,* 1992].

Some research finds it useful to treat *M* as a variable. Assuming a constant growth rate *g* over the modelling period, has often produced a more accurate and believable forecast. This is an indirect way to reflect the growth that occurs in a market when the average price drops and the demand for the product/service expands. It is also probably best to treat *M* as fixed because numerous studies have shown the simple model to be very flexible and robust [*Bass,* 2004].

Estimating *p* и *q*

Most applications of the model make plans and decisions before the product/service is introduced in the market. No sales data thus exist with which to estimate *p* or *q*. Managers do not have an intuitive estimate of *p* and *q*. The practical approach is to use the coefficients estimated from the diffusion patterns of analogous products. The average values across a wide range of products is $p =$

Table 2. **Bass Model Parameter Estimated based on similar products**

Product	Period of Analysis	*p*	*q*
Ultrasound imaging	1965–1978	0	0.534
Mammography	1965–1978	0	0.729
CT scanners (50–99 beds)	1980–1993	0.44	0.35
CT scanners (>100 beds)	1974–1993	0.036	0.268
Weighted Average for Telemedicine		**0.119**	**0.47025**

Source: calculated by the authors.

0.03 and $q = 0.38$. Industry-specific data are available for consumer electronics, appliances, medical equipment, pharmaceutical drugs, semiconductors, agricultural equipment, etc. [*Bass et al.*, 1994].

The best process is to use analogues based on similarities in expected market reactions rather than the product category. For example, the adoption of satellite radio is more likely to be similar to cable TV than the adoption of radio. The first generation of radio had no direct competition and was free. Satellite radio has adopted a subscription-pricing model and faces a direct competitor; these are similar dynamics that cable TV faced in converting consumers from free TV to cable service. If necessary, we can consider a weighted average of p and q values across several categories or apply a Bayesian weighting that can be updated as new information is collected [*Bass*, 2004; *Ofek*, 2005].

In order to forecast the adoption rate of telemedicine in American rural areas, we have to estimate the three parameters m, p and q.

Determination of Total Market Size (m), Selection of Coefficients of Innovation (p) and Imitation (q)

First, we need to estimate m — the total potential market size. According to the Economics Research Service at the United States Department of Agriculture, there are about 51 million (m = 51 million) Americans living in rural areas as of July 2011.

The Coefficients of Innovation (p) and Imitation (q) should be developed by the coefficients (p & q) of existing products at the time, according to which the products are selected to estimate telemedicine coefficients. The products that are used for the estimations should have similar data to telemedicine. There are four kinds of medical equipment products that we can use to estimate these two parameters: ultrasound imaging, mammography, CT scanners (50–99 beds), and CT scanners (>100 beds). Table 2 below sets out the weighted average values as: $p = 0.119$ and $q = 0.47025$.

By using the weighted average $p = 0.119$, $q = 0.47025$ and m = 51 million, we can then forecast the adoption as shown below.

Estimation of Demand Forecast

We used own estimates of m, p, and q to illustrate how fast or slow the adoption of e-books will occur. The product life is expected to be 22 years.

m = 51 million
$p = 0.119$
$q = 0.47025$

At t = year 1, N (t–1) = 0

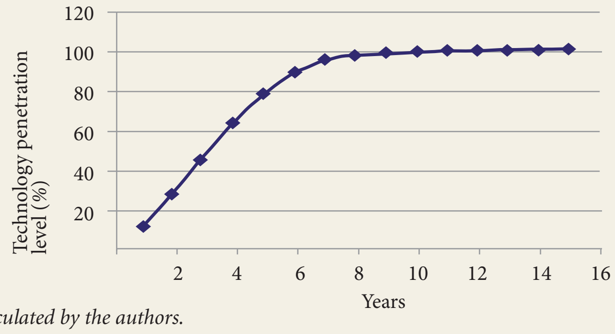
Then, $S(t) = [p + (q/m)\, N(t-1)][m - N(t-1)]$
$= [0.119 + (0.428*0)]*(51-0)$
$= 6.0690$

And $N(t) = S(t) - N(t-1)$
$= 6.0690 - 0$
$= 6.0690$

From Figure 2 and Table 3, we can estimate the adoption rate of telemedicine. In rural US, the adoption rate will rapidly increase from year 1 to 7, followed by a decline. By year 15, the adoption rate will be 100%.

Moreover, the coefficient of innovators is smaller than the coefficient of imitators. It causes the slope of the curve to be shallow, meaning that in the case of adoption of telemedicine in rural US, imitators are able to gauge gaps or opportunities while launching their products to compete in the market.

Fig. 2. **Bass Model Market Penetration Curve**



Source: calculated by the authors.

Table 3. **The Bass model forecasting with m= 51 (in million) p=0.119, and q=0.47025**

t (years)	$N(t)$	$S(t)$	$N(t)/m$ (%)	$S(t)/m$ (%)
1	6.0690	6.0690	11.90	11.90
2	13.9301	7.8611	15.41	27.31
3	23.1028	9.1727	17.99	45.30
4	32.3653	9.2625	18.16	63.46
5	40.1439	7.7786	15.25	78.71
6	45.4542	5.3103	10.41	89.13
7	48.4385	2.9843	5.85	94.98
8	49.8873	1.4489	2.84	97.82
9	50.5316	0.6442	1.26	99.08
10	50.8056	0.2740	0.54	99.62
11	50.9198	0.1142	0.22	99.84
12	50.9670	0.0472	0.09	99.94
13	50.9864	0.0194	0.04	99.97
14	50.9944	0.0080	0.02	99.99
15	50.9977	0.0033	0.01	100.00

Source: calculated by the authors.

Conclusion

The Bass model is one of the best forecasting tools for predicting the adoption of a new product. However, there will still be room for error in this model. On another note, several barriers to adoption will affect the implementation rate of telemedicine. We group these barriers into four main categories: financial, technical, logistical, and cultural.

The top three factors under the financial barriers are start-up costs, ongoing costs, and reimbursement or incentives. Telemedicine consists of high technology systems that entail complex hardware and software that demand a specific level of computer skills from providers, physicians, and patients. Factors leading to technical barriers include a lack of computer skills, training and technical support, and infrastructure.

The logistical barriers of telemedicine represent a significant barrier to its widespread implementation. Regulatory issues have been identified as a barrier to implementing telemedicine programs. According to a recent survey, putting in place licensed out-of-state physicians, credentials of medical staff privileges at individual facilities, and malpractice liability are the three significant impediments to a telemedicine solution.

Cultural barriers are some of the most important barriers to the widespread adoption of telemedicine. They can be categorized into two main kinds: acceptance by physicians and patients' satisfaction. Physician acceptance includes everything related to their discomfort in using novel technological equipment in their daily practices and treating patients from a distance. Physician acceptance of telemedicine also includes quality, personal preference and previous experience, control of patient care, convenience, and reimbursement potential. Patient satisfaction includes anything that could decrease their satisfaction while using telemedicine. Patients in general are worried about the quality of remote healthcare services.

References

ATA (2015) *Telemedicine/Telehealth Terminology*, Washington, D.C.: American Telemedicine Association. Available at: http://www.americantelemed.org/docs/practice-telemedicine/glossaryofterms.pdf, accessed 12.06.2015.

Bass F.M. (2004) Comments on A New Product Growth for *Model* Consumer Durables. *Management Science*, vol. 50, no 12, pp. 1833–1840.

Bass F.M., Trichy K., Jain D.C. (1994) Why The Bass Model Fits Without Decision Variables. *Management Science*, vol. 13, no 3, pp. 203–223.

Bates D.W. (2002) The quality case for information technology in healthcare. *BMC Medical Informatics and Decision Making*, vol. 2, no 7, pp. 1–9.

Casalino L., Gillies R.R., Shortell S.M., Schmittdiel J.A., Bodenheimer T., Robinson J.C., Rundall T., Oswald N., Schauffler H., Wang M.C. (2003) External incentives, information technology, and organized processes to improve health care quality for patients with chronic diseases. *JAMA: The Journal of the American Medical Association*, vol. 289, no 4, pp. 434–441.

CMS (2012) *National Health Expenditure Data*, Baltimore, MD: Centers for Medicare & Medicaid Services. Available at: http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/tables.pdf, accessed 02.04.2015.

Craig J., Patterson V. (2005) Introduction to the practice of telemedicine. *Journal of Telemedicine and Telecare*, vol. 11, no 1, pp. 3–9.

Croteau A.M., Vieru D. (2002) *Telemedicine adoption by different groups of physicians*. Paper presented at the 35th Hawaii International Conference on System Sciences, IEEE Computer Society.

DePhillips H. (2007) Initiatives and Barriers to Adopting Health Information Technology: A US Perspective. *Disease Management & Health Outcomes,* vol. 15, no 1, pp. 1–6.

EHTEL (2008) *Sustainable Telemedicine: Paradigms for future-proof healthcare* (A briefing paper, version 1.0), Brussels: European Health Telematics Association.

Field M.J., Grisby J. (2002) Telemedicine and remote patient monitoring. *JAMA: The Journal of the American Medical Association*, vol. 288, no 4, pp. 423–425.

Frist W.H. (2005) Shattuck Lecture: Health care in the 21st century. *New England Journal of Medicine*, vol. 352, no 3, pp. 267–272.

Gagnon M.-P., Godin G., Gagné C., Fortin J.-P., Lamothe L., Reinharz D., Cloutier A. (2003) An adaptation of the theory of interpersonal behavior to the study of telemedicine adoption by physicians. *International journal of medical informatics*, vol. 71, no 2–3, pp. 103–115.

Hu P.J., Chau P.Y., Sheng O.L. (2000) *Investigation of factors affecting healthcare organization's adoption of telemedicine technology*. Paper presented at the 33rd Hawaii International Conference on System Sciences, IEEE Computer Society.

Jha A.K., Ferris T.G., Donelan K., DesRoches C., Shields A., Rosenbaum S., Blumenthal D. (2006) How common are electronic health records in the United States? A summary of the evidence. *Health Affairs (Millwood)*, vol. 25, no 6, pp. 496–507.

Kijsanayotin B., Pannarunothai S., Speedie S.M. (2009) Factors influencing health information technology adoption in Thailand's community health centers: Applying the UTAUT model. *International Journal of Medical Informatics*, vol. 6, pp. 404–416.

Kuperman G.J., Gibson R.F. (2003) Computer physician order entry: Benefits, costs, and issues. *Annals of Internal Medicine*, vol. 139, pp. 31–40.

Makena R., Hayes C.C. (2011) Flexible Usage of Space for Telemedicine Systems, Man, and Cybernetics (SMC). *Proceedings of the IEEE International Conference*, pp. 1134–1139.

Norton J., Bass F. (1992) Evolution of Technological Generations: The Law of Capture. *Sloan Management Review*, vol. 33, pp. 66–77.

NQF (2010) Privacy: From Barrier to Enabler of Health Information Technology (HIT). *National Quality Forum Brief*, no 18, pp. 1–6.

Ofek E. (2005) *Forecasting the Adoption of E-books* (Harvard Business School Exercise 505063, May 2005), Boston, MA: Harvard Business School.

Ofek E. (2006) *Forecasting the Adoption of a New Product* (Harvard Business School Background Note 505-062), Boston, MA: Harvard Business School.

Ramos V. (2010) *Contributions to the History of Telemedicine of the TICs*. Paper presented at the Second IEEE Region 8 Conference on the History of Telecommunications (HISTELCON), 3–5 November.

Rao B., Lombardi A. II. (2009) Telemedicine: Current status in developed and developing countries. *Journal of Drugs in Dermatology*, vol. 8, no 4, pp. 371–375.

Schoen C., Osborn R., Huynh P.T., Doty M., Peugh J., Zapert K. (2006) On the front lines of care: Primary care doctors' office systems, experiences, and views in seven countries. *Health Affairs (Millwood)*, vol. 25, no 6, pp. 555–571.

Stanberry B. (2000) Telemedicine: Barriers and opportunities in the 21st century. *Journal of Internal Medicine*, vol. 247, no 6, pp. 615–628.

Tan J., Cheng W., Rogers W.J. (2002) From Telemedicine to E-Health: Uncovering New Frontiers of Biomedical Research, Clinical Applications & Public Health Services Delivery. *Journal of Computer Information Systems*, vol. 42, no 5, pp. 7–18.

Trembly A.C. (2001) Federal Study Supports Telemedicine, But Health Insurers Remain Skeptical, National Underwriter. *LifeHealthPRO*, 16.04.2001. Available at: http://www.lifehealthpro.com/2001/04/16/federal-study-supports-telemedicine-but-health-ins, accessed 12.04.2015.

Vo A., Brooks B.G., Farr R., Raimer B. (2011) *Benefits of Telemedicine in Remote Communities & Use of Mobile and Wireless Platforms in Healthcare*, Galveston, TX: University of Texas.

WHO (2010) *TELEMEDICINE Opportunities and developments in Member States* (Report on the second global survey on eHealth Global Observatory for eHealth series, vol. 2), Geneva: World Health Organization.