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The Illinois Institute for Rural Affairs (IIRA) works to improve the quality of life for rural residents by partnering with public and private agencies on local development and enhancement efforts.

Western Illinois University

The Value of Telemedicine

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Abstract

This paper constructs a theoretical framework that aids in evaluating people's subjective utility of telemedicine, empirically tests the factors related to utility assessment, and employs relevant factors to compute the economic value of telemedicine for Illinois. The 'value' analysis, performed at the county level, is based on a combination of secondary analysis of survey data from MCBS, and CMS' Carrier file data. Results of data analysis suggest that from 2019 to 2020, telemedicine generated $1bil in healthcare savings for IL. The paper provides an interactive computer application to visualize value metrics for the counties.

1. Introduction

Telemedicine, the use of information and communication technologies (ITC) to provide care to patients[2], has become a sought-after mode of healthcare in the nation[3]; Athiyaman (2021a, b) posits that awareness about telemedicine among Medicare and Medicaid members, during the peak of the Covid-19 pandemic, June-July 2020, increased by 25%, or approximately by 8mil members. The usage rate of telemedicine among Medicare/Medicaid recipients is about 45% [4] .

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[2] The Agency for Healthcare Quality and Research (AHRQ) defines telehealth as the use of ITC in healthcare delivery for a specific patient or group of patients that involves collaboration with a healthcare professional across distance or time to address a diagnosis, health condition, or the overarching needs of a patient; see https://digital.ahrq.gov/key-topics/telehealth.

[3] See , for example, the American Telemedicine organization's MedPac letter dated January 22, 2021; www.american-telemed.org and Congressional Research Service (CRS): *Legal Side Bar*, LSB 10490, June 5, 2020.

[4] Of the approximately 31mil Medicare/Medicaid recipients in the nation, some 13.9mil report using telemedicine during June-July and October-November 2020; see 2020 Medicare Current Beneficiary Survey (MCBS), Covid-19, Summer and Fall supplements.

In the Midwest, Covid-19 has made more people aware about telemedicine (26% became aware during the pandemic, N ~ 4.02mil); in all, 1.91mil Medicare and Medicaid recipients in the Midwest (48% of the total enrollees) reported using the service during June-November 2020[5]. Appendix 2 highlights changes to telemedicine use in Illinois during the 2014-2019 time period[6].

Behavioral science explains that an individual's preference for a good or service can be predicted from a knowledge of the antecedent states of the individual and the relevant environmental conditions; for example, one's need for healthcare may be satisfied by one's visit to the local hospital, the hospital becomes an object of "value" for the individual[7].

In this paper, the value of telemedicine for rural Illinois is explored. In economic theory, value is defined as "benefits less costs". Attributes of a good or service are evaluated for utility; positive utility is attached to benefits and negative utility to costs. The difference between the sum of positive and negative utilities is the value of the good or the service[8]. This type of reasoning is used below to deduce theorems about telemedicine use among Medicare and Medicaid recipients and to deduce value of telemedicine for rural economies.

2. Theory and Theorems

A consumer has to use or trial telemedicine to learn about it, for example, that it is an effective mode of healthcare[9]. The consumer could view this as risky because the outcomes of telemedicine services are not known with certainty[10]. To elaborate, there are two facets of patient health data, physical (for example, measures of the patient's vitals) and verbal (patient's self-reports about her health). For telemedicine, unless it is a follow-up care after visiting a physician who has knowledge of the patient's health metrics[11], the physical data are absent; in this situation, telemedicine may not be an effective (healthcare) solution for the patient, it could be a risky choice.

[5] See Appendix 1 for data tables.

[6] Healthcare Common Procedure Coding System (HCPCS) / Current Procedural Terminology (CPT) codes for telemedicine are numerous; see MLN 901705, March 2020, for an overview about telehealth codes; Appendix 2 highlights a few of these codes, all telemedicine services.

[7] This argument is from learning theory; expressed as an equation, Value drive *Behavior = Motivation (Need) x Habit Strength (loosely, liking to engage in behavior)*.

[8] This is "habit strength" in learning theory; in economics, one's need (for example, thirst) is conceptualized as pain; it's relief (for example, water) is labeled "pleasure".

[9] Vicarious learning such as learning from advertisements is also possible, but not explicitly stated here.

[10] A recent AHQR study suggests that telehealth could benefit some specialties such as wound care and psychiatry; wound care witnessed better healing and fewer amputations and psychiatry reported decrease in symptoms; see Seehusen and Azrak, (2019).

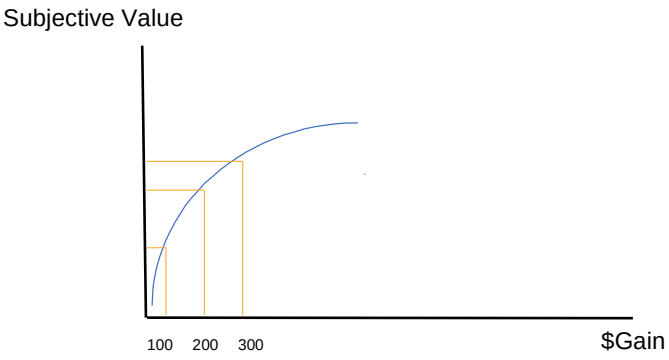
[11] In Illinois, this type of telemedicine consultation registered a 13.17% increase in usage during the 2014-2019 time period.

Decision theory states that to make risky decisions, one has to consider two factors, the desirability of plausible outcomes and their probability of occurrence. Consider a choice situation where one can win $100 for sure or win $200 with a 50% chance, the expected value of winning $200 is the same as winning $100[12]. A preference for a sure outcome over a risky one that has an equal or higher expected value[13] is called "risk averse"; its opposite, seeking risky outcomes, is labeled "risk seeking". In general, people are risk averse for positive outcomes and risk seeking for negative outcomes (for example, people prefer to lose $200 with a 50% chance than to lose $100 for sure).

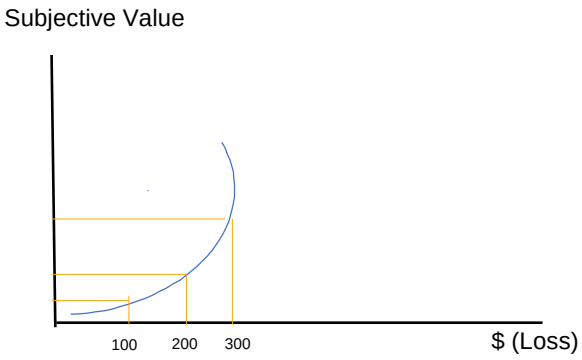
The subjective value or utility is a diminishing function, for example, the impact of $100 is greater when it is added to an additional $100 than when it is added to $800; Figure 1a illustrates this diminishing sensitivity for risk aversion. The concept of diminishing sensitivity applies to losses as well; the worth of a gamble that offers a 50% chance to lose $200 is less negative than that of a sure loss of $100 (risk seeking, Figure 1b).

Figure 1: Subjective Value or Utility Functions

1a. Risk Aversion (Concave)



1b. Risk Seeking (Convex)

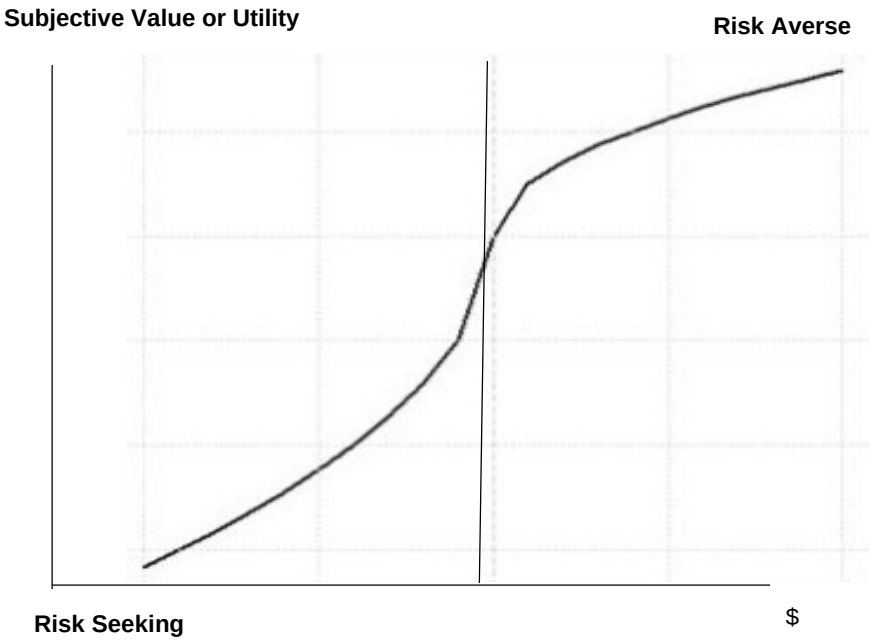


If we conjoin Figures 1a and 1b, we obtain the prospect theory for risky choice shown in Figure 2 (Kahneman and Tversky, 1979). The properties of the value function shown in Figure 2 include: (i) it is defined on gains and losses rather than total wealth; (ii) it is steeper for losses than for gains, and (iii) it is concave for gains and convex for losses. These properties together and in combination suggest the following theorems about the value of telemedicine.

[12] *Expected Value (EV) = 0.5 x $200 + 0.5 x $0 = $100*

[13] Expected value is often replaced with the term "expected utility" to account for the ordinal properties of the subjective value measure; see Figures 1 and 2.

Figure 2: Value Function for Gains and Losses



To use telemedicine, one may need access to devices such as smartphone and Internet connection. Healthcare consumers with access to these technologies could view telemedicine as a gain; there is evidence of cost savings with telehealth[14]. The opposite could be true for healthcare consumers who don't have access to technology; these consumers could think of telemedicine as a loss, spend $*x* in communications technology now to use telemedicine, which may or may not provide the outcomes that they seek. For these consumers, a visit to the doctor's office could provide better outcomes than telemedicine; the above argument suggests:

T_1: Telemedicine use will be higher among patients with access to information and communications technology.

Consider the property of the value function (Figure 2), that one's value assessment of a monetary gain or loss is independent of one's preexisting wealth. The property, taken at its face value, requires an empirical assessment of the relationship between income and value assessments for telemedicine; the *a priori* expectation is to find little or no correlation between one's subjective value of telemedicine and income. However, for one to use telemedicine, one needs to be aware of the service and should have a favorable

[14] American Academy of Family Physicians. Telehealth and telemedicine; www.aafp.org/about/policies/all/telemedicine.html.

disposition[15] towards the service, conceptually, preexisting, cognitive and affective "wealth". Favorable disposition is based on benefit beliefs such as savings in travel time to the doctor's office and visit costs[16]. This favorable disposition, along with one's need for healthcare, should result in one's use of telemedicine. Thus,

> T_2: The concepts, "subjective value of telemedicine" and "income", will be independent; and

> T_3: Telemedicine use will be higher among consumers with positive attitude towards the service.

In their research into the effectiveness of outpatient telehealth consultations, Seehusen and Azrak (2019) claim that user satisfaction is similar for standard care (office visits) and telehealth. Yet, in Illinois, only 7.4% of Medicare beneficiaries in 2019 chose telemedicine[17]. In other words, two logically equivalent services give rise to different choices.

The principle, that the loss function is steeper than the gain function (Figure 2), can be used to explain this discrepancy; the property implies that the loss of utility associated with giving up something that is in our possession is greater than the utility gain associated with obtaining it. Applied to healthcare, it suggests that someone who normally visits his doctor's office for health consultations may be reluctant to give that up and switch to telemedicine; see Reed et al (2020) for evidence in this direction. Hence,

> T_4: There will be a strong tendency for people who visit a particular location for medical care (for example, Medical Clinic) to maintain the status quo[18].

In summary, the value of telemedicine at the individual level can be ascertained using the postulates of prospect theory. An empirical test of the four theorems outlined in the section would inform the construction of the metric, "value of telemedicine" at the regional level, metro and nonmetro counties in Illinois; see methods section for computational details.

[15] Disposition is defined as one's positive evaluation of telemedicine; in marketing, ones disposition towards a concept is labeled one's 'attitude" towards the concept.

[16] See for example, JAMA Network Open. 2020,3(6): e.205873. doi:10.1001/jamanetworkopen.2020.5873.

[17] Author's computation, based on 2019 Part B Carrier Summary File; CMS data. The carrier code for Illinois is 06102.

[18] Behavioral theory would explain this in terms of need satisfaction and reinforcement; see Athiyaman (2020). Opioid use in nonmetro Illinois. http://www.iira.org/wp-content/uploads/2020/06/Opiod_2020_draft.pdf

3. Methodology

To test the theorems, data from the MCBS, Fall 2020 Covid-19 supplement, were used. The survey was fielded during October 5, 2020 – November 15, 2020 and included a representative national sample of the Medicare population; a total of 9,686 were interviewed[19]. The theorems were operationalized using the variables shown in Table 1. Statistical tests of the theorems or hypotheses include tests concerning differences between means, differences among proportions, and tests of independence in contingency tables.

Table 1: Operational Definitions of Variables[20]

Construct	Measure of the Construct, from MCBS	Data Type
Telemedicine Use	ACV_TELMEDUS; Since July 1, 2020, have you had an appointment with a doctor or other health professional by telephone or video?	Nominal.
ICT Access	Multiitem measure; $\sum AC\,V_{COMPDESK}, AC\,V_{COMPPHON}, AC\,V_{COMPTAB}, AC\,V_{INTERNET}, AC\,V_{AUDIOVIDEO}$	Interval, data range 0-5.
Income	DMV_INCOME; Income group: LT $25,000; GTE $25,000	Nominal.
SV Telemedicine[21]	ACV_TELMEDT4; Type of telehealth visit, telephone or video.	Ordinal.
Attitude towards Telemedicine[22]	Multiitem measure; $\sum PK\,V_{PREVCLEA}, PK\,V_{PREVDIST}, PK\,V_{PREVFACE}, PK\,V_{PREVGRP}, PK\,V_{PREVMASK}, PK\,V_{PREVSHEL}$	Interval, data range 0-6.
Loyalty to Service Provider	ACV_PLACKIND; kind of place usually go to for medical care.	Nominal

[19] See https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/MCBS-Public-Use-File.
[20] See Appendix 3 for more about measures.
[21] See Appendix 3 for more about measures.
[22] The subjective value (SV) of telemedicine was measured using an ordinal, 1,2, and 3 indicators; the assumption is that a person who uses telephone and video for consulting with her physician (indicator 3) will value the encounter more than a person who uses only voice or telephone (indicator 1) to communicate with the doctor.
[23] See Appendix 3; the measure, a proxy variable, is based on one's Covid-19 preventive behavior.

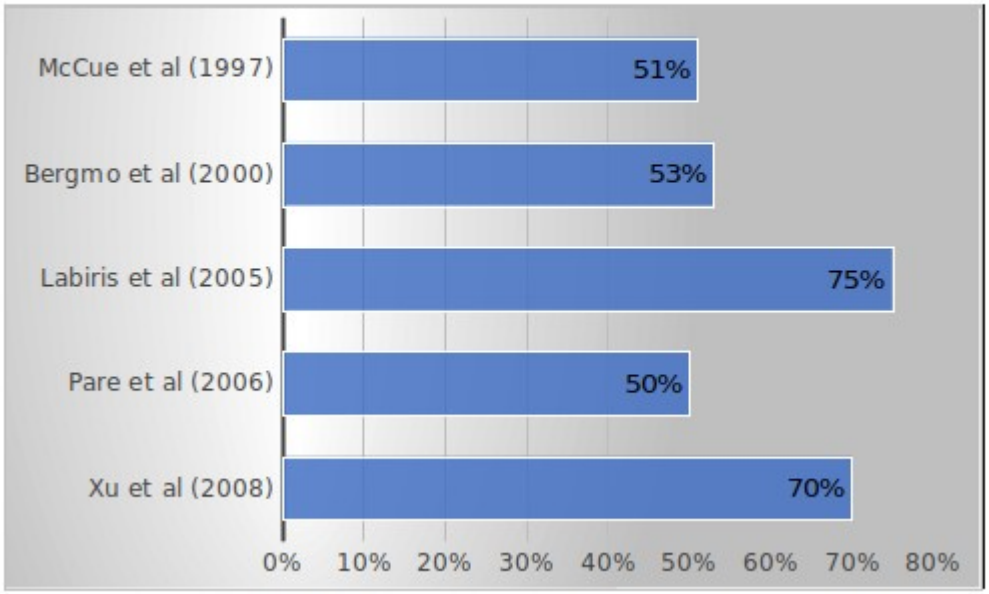
To estimate the economic value of telemedicine for rural economies, program codes relevant for the service was obtained from CMS;[23] in all, 19 programs were analyzed (Appendix 4).

Analytical computations of telemedicine value relied on the variable "attitude towards telemedicine" given in Table 1 and factors listed in Table 2; for example, given variables *P* and *C*, the number of telemedicine users (*H*) at county *i*, for each of the 19 programs were estimated using the expression:

Hij = P x C x No. of procedures for HCPCS or CPT code j (j=1 to 19)

Similarly, forecasts for telemedicine use in 2020 were obtained using a naïve forecasting model and telehealth regional tracker data[24]; the former was set as the lower estimate for telemedicine use and the latter, upper level forecast, see variables *FHL* and *FHH* in Table 2.

Figure 3: Relative Cost of Telemedicine, Compared to the Traditional Model



[23] 2019 Part B Carrier summary data file; https://www.cms.gov/Research-Statistics-Data-and-Systems/Downloadable-Public-Use-Files/Part-B-Carrier-Summary-Data-File/Overview.

[24] https://www.fairhealth.org/article/fair-health-tracker-shows-continuing-growth-in-telehealth; the urban versus rural telemedicine usage numbers during November 2019 to November 2020 were used to compute annual growth rate; 394% for metro and 329% for nonmetro.

Finally, the value of telemedicine to rural counties was derived using provider costs for the service, accounting costs for telemedicine that have been reported in journal publications (Figure 3)[25], and community attitude towards telemedicine[26]. Technically, 'value' is monetary savings in healthcare costs for the community, the difference between the average cost of traditional procedure and the mean expenditure for telemedicine. To ease the burden of reading through multiway frequency tables, a software is provided; Appendix 5 is an example of a multiway table, it lists the number of telemedicine users in rural Illinois counties during 2019, classified by each of the 19 programs. The software is to assist healthcare managers and community economic developers visualize the value of telemedicine for their county, without having to leaf through multiple numerical tables.

[25] Data range, 25**%**, is used to deduce 28% cost advantage for telemedicine over the traditional mode.

[26] Attitude towards telemedicine signals the community's valuation or evaluation of the service; a positive evaluation would result in repeat use of the service.

Table 2: Input Factors for Telemedicine Value Analysis

Symbol and Description	Measure / Operational Definition	Source
N: Number of Medicare beneficiaries in metro and nonmetro Illinois, by county.	Numerical, ratio-level measure; input variable.	ACS, 2019, 5-year estimates; Table S27010.
P: Medicare beneficiaries in county *i*, *i* = 1 to 102, in proportion to their regional (metro / nonmetro) total.	Numerical, ratio-level measure; input variable. $\frac{N\text{, County } i}{\text{Regional Total}}$	ACS, 2019, 5-year estimates; Table S27010.
H: No. of telemedicine users at county i, for each of 19 HCPCS / CPT codes.	Numerical, ratio-level measure; input variable. $H_{ij} = P \times C \times No.\ Of\ \ procedures$ *for HCPCS or CPT code j (j=1 to 19)*	Number of procedures for Illinois for each of the HCPCS / CPT codes were obtained from 2019 Part B Carrier Summary Data File.
FHL: Forecast of **H** (low value) for 2020.	Numerical, ratio-level measure; input variable. $FH_{ij}L = H_{ij2019} \times \frac{H_{ij2019}}{H_{ij2018}}$	For H_{2019}, data source is given above; for H_{2018}, data were obtained from 2018 Part B Carrier Summary Data File.
FHH: Forecast of **H** (high value) for 2020.	Numerical, ratio-level measure; input variable. $FH_{ij}H = H_{ij2019} \times$ *Metro or Nonmetro Growth in Telehealth* Metro growth = 394% Nonmetro growth = 329%.	Growth numbers for the regions were obtained from *Monthly Telehealth Regional Tracker;* data are for the Midwest region for the period 11/2019 to 11/2020.

4. Results and Discussion

4.1 ICT and Telemedicine

The hypothesis that telemedicine use will be related to ICT access was confirmed by a χ^2 test, Table 3. A high level of ICT access is associated with the metro population, 77% for the metro compared with 65% for the nonmetro. While there is little or no difference in high level ICT access between the genders, race does make a difference, Caucasians have higher level ICT access compared to Blacks and Hispanics, 79% for the Caucasians versus 63% for the Blacks and 57% for the Hispanics. Age is another predictor of high-level ICT access, the relation is "U" shaped, with the 65-74 age group having less access to ICT than the 75+ age group. Table 4 lists the demographics that are correlated with high ICT access.

Table 3: Impact of ICT Access on Telemedicine Use

Telemedicine Use	**ICT Access Level[27]**	
	Low	**High**
Yes	42%	46%
No	58%	54%
All Respondents (N)	7,678,314	23,296,786

$\chi^2 = 31659$; $p < 0.05$

Table 4: Tests of Independence: ICT Access and Demographic Variables

(1) Impact of Geography

Level of ICT Access	**Region**	
	Metro	**Nonmetro**
High	77%	65%
Low	23%	35%
Number of Respondents	25,928,417	4,951,220

$\chi^2 = 342079$; $p < 0.05$

[27] Median split was used to dichotomize the ICT Access variable, median = 3.

(2) Impact of Race

	Race		
Level of ICT Access	**Caucasian**	**Black**	**Hispanic**
High	79%	63%	57%
Low	21%	37%	43%
Number of Respondents	23,403,366	2,884,773	2,695,854

$\chi^2 = 899017$; $p < 0.05$

(3) Impact of Age

	Age		
Level of ICT Access	**< 65**	**65-74**	**≥ 75**
High	82%	63%	75%
Low	18%	37%	25%
Number of Respondents	16,095,992	8,902,329	5,902,485

$\chi^2 = 120286$; $p < 0.05$

4.2 Telemedicine Use and Wealth

Theorems 2 and 3 predict the association between telemedicine use and service users' wealth, both monetary and attitudinal wealth. For monetary wealth, theorem 2 predicts no relationship with subjective utility assessments; this prediction is validated by empirical tests, the correlation between the two variables is 0.03[28]. For attitude, theorem 4 implies a dependent relationship for the variable with telemedicine. This association is verified in Table 5; $\chi^2 = 286$; $p < 0.05$.

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Table 5: Impact of Telemedicine Attitude on Telemedicine Use

Use of Telemedicine	**Attitude towards Telemedicine**	
	Low	**High**
Yes	45%	56%
No	55%	44%
Number of Respondents	15,364,793	15,989,872

[28] Yules *Q* was the statistic that was computed.

To explore the profile of people with positive attitude towards telemedicine, respondents' demographics such as gender and age were crossed with respondents' low and high attitude scores. The results reveal that being a female, less than 65-year old, Hispanic, and residing in the metros are the typical attributes of a person with positive attitude towards telemedicine (Table 6).

Table 6: Tests of Independence: Attitude towards Telemedicine and Demographic Variables

(1) Impact of Geography

	Region	
Attitude	**Metro**	**Nonmetro**
High	52%	47%
Low	48%	53%
Number of Respondents	26,303,567	5,029,928

$\chi^2 = 46637$; $p < 0.05$

(2) Impact of Race

		Race	
Attitude	**Caucasian**	**Black**	**Hispanic**
High	46%	66%	75%
Low	54%	34%	25%
Number of Respondents	23,676,881	2,934,113	2,791,250

$\chi^2 = 111021$; $p < 0.05$

(3) Impact of Age

		Age	
Attitude	**< 65**	**65-74**	**≥ 75**
High	49%	49%	58%
Low	51%	51%	42%
Number of Respondents	16,279,796	9,045,388	6,029,480

$\chi^2 = 166848$; $p < 0.05$

(4) Impact of Gender

Attitude	Gender	
	Female	Male
High	56%	45%
Low	44%	55%
Number of Respondents	17,502,928	13,851,737

$\chi^2 = 412694$; $p < 0.05$

4.3 Behavioral Loyalty

More than nine out of ten respondents report visiting a particular place for health care; this behavioral loyalty to a place of healthcare does not depend on the geographical location of the respondent, both metro and nonmetro residents exhibit high loyalty (Table 7). In summary, the predictions of theorem 4 for the presence of high behavioral loyalty in healthcare is confirmed.

Table 7: Loyalty to Healthcare Provider

Go to a Particular Place for Medical Care	Geographical Region	
	Metro	Nonmetro
Yes	95%	95%
No	5%	5%
Number of Respondents	44,216,204	10,978,977

$\chi^2 = 2069$; $p < 0.05$

Further analysis of behavioral loyalty to healthcare provider reveals (1) that a higher proportion of Midwest residents report using emergency care facilities such as hospital ER regularly; (2) higher household income is associated with loyalty; (3) metro residents tend to be more loyal to their doctor's office; (4) VA facilities are visited more often by rural residents; (5) a higher proportion of Caucasians report loyalty to their doctor; (6) higher the age, more the loyalty to the doctor's office, and (7) females are more loyal to their healthcare provider (Table 8).

Table 8: Tests of Independence: Provider Loyalty and Demographic Variables

(1) Impact of Geography

Loyalty to ….	Region	
	Metro	**Nonmetro**
Dr's Office	88%	85%
Other Facilities	12%	15%
Number of Respondents	41,991,916	10,401,808

χ^2 = 966910; p < 0.05

(2) Impact of Race

Loyalty to ….	Race		
	Caucasian	**Black**	**Hispanic**
Dr's Office	89%	83%	80%
Other Facilities	11%	17%	20%
Number of Respondents	39,737,186	5,083,451	4,355,651

χ^2 = 860268; p < 0.05

(3) Impact of Age

Loyalty to ….	Age		
	< 65	**65-74**	**≥ 75**
Dr's Office	86%	87%	89%
Other Facilities	14%	13%	11%
Number of Respondents	10,357,242	25,345,165	16,727,833

χ^2 = 69771; p < 0.05

(4) Impact of Gender

Loyalty to ….	Gender	
	Female	**Male**
Dr's Office	89%	85%
Other Facilities	11%	15%
Number of Respondents	28,918,529	23,511,711

χ^2 = 1284059; p < 0.05

4.4 Summary of Theory Testing

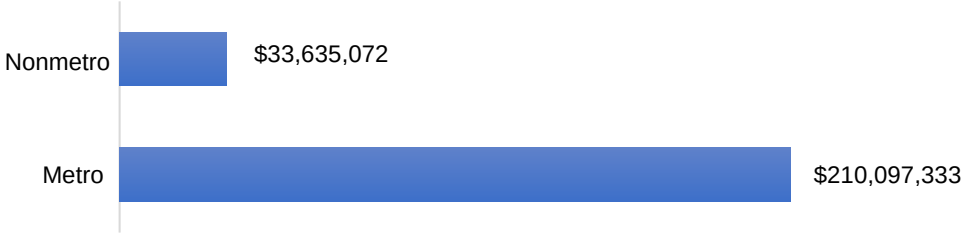
Our theoretical conceptualization of telemedicine use invoked the notion of value function, which reflects people's evaluation of gains and losses. The results of empirical testing of the theory suggest that investments in ICT, enablers or facilitators of telemedicine use, could be viewed as losses; put differently, unless ICT is widespread among the population, use of telemedicine services would suffer.

Additional psychological principles were introduced to account for telemedicine use, for example, one's habit strength (attitude). Empirical analysis highlights that being a female, less than 65-years old, Hispanic, and residing in the metros are the typical attributes of a person with positive attitude towards telemedicine. Geographically, metro residents evaluate telemedicine more positively than their nonmetro counterparts. We make use of these findings next to compute the economic value of telemedicine to rural economies.

4.5 Value of Telemedicine

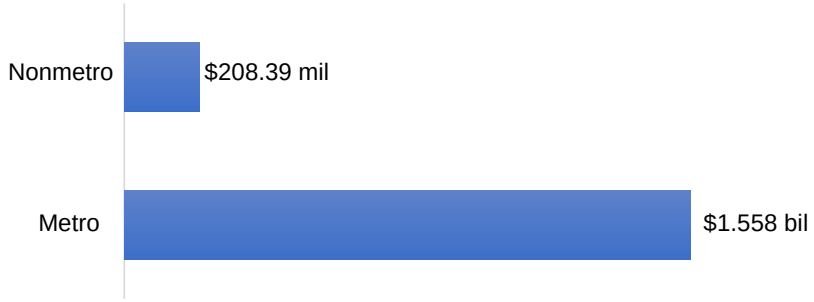
It is estimated that in 2020, telemedicine benefits to rural Illinois totaled at least $33.63mil; a conservative estimate of telemedicine benefits for metro Illinois is $210.09mil. It is essential to note that these are cost savings on healthcare spending, telemedicine replacing traditional care (Figure 2).

Figure 2: Value of Telemedicine, Conservative Estimates for 2020



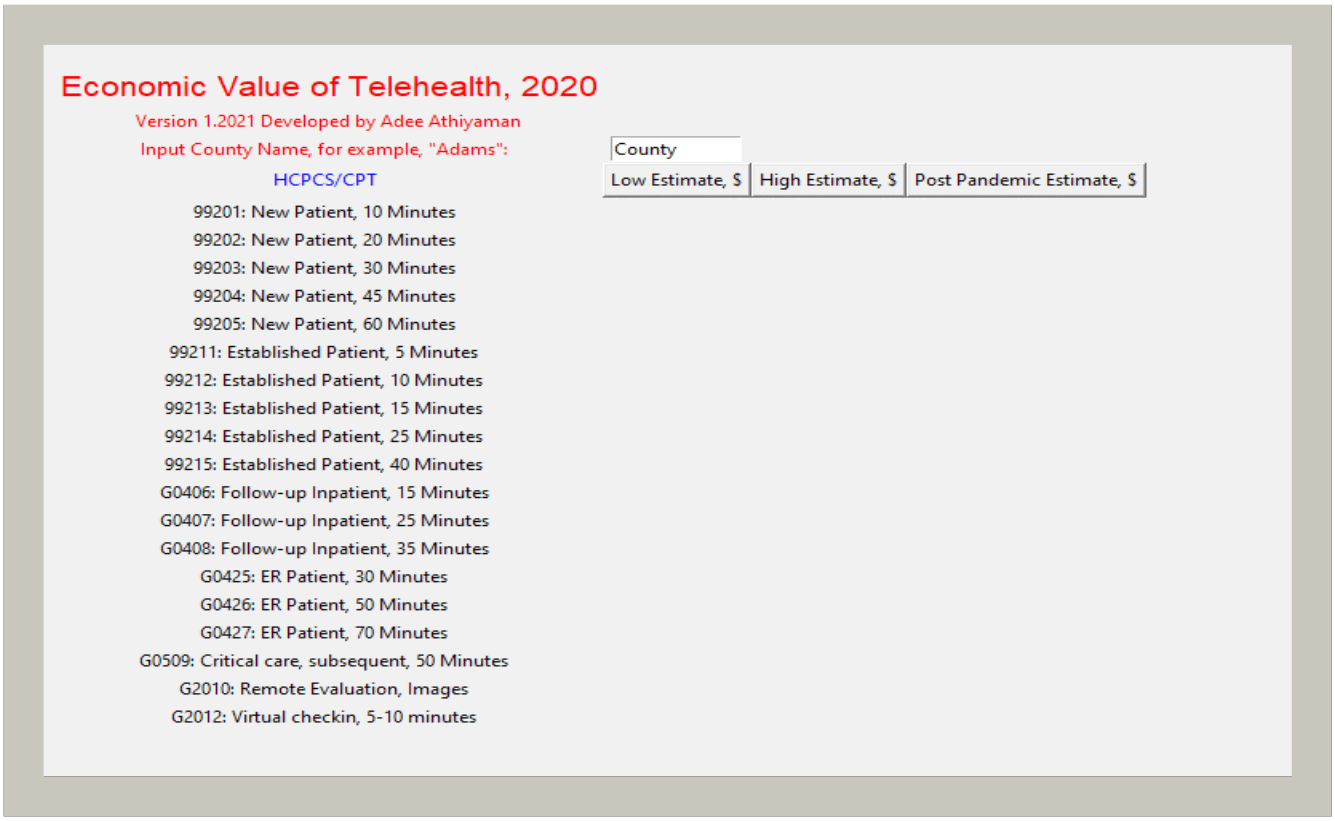
As mentioned earlier, two different scenarios were employed to forecast telemedicine user numbers, a naïve model and an exponential growth model using data from *Monthly Telehealth Regional Tracker*. The 'value' computations given in Figure 2 are based on the naïve model, a low estimate. Calculations based on the exponential model are the upper value and these are shown in Figure 3. The computations suggest that telemedicine values for the counties in 2020 were six to seven folds greater than the 2019 values.

Figure 3: Value of Telemedicine, Upper-Interval Estimates for 2020

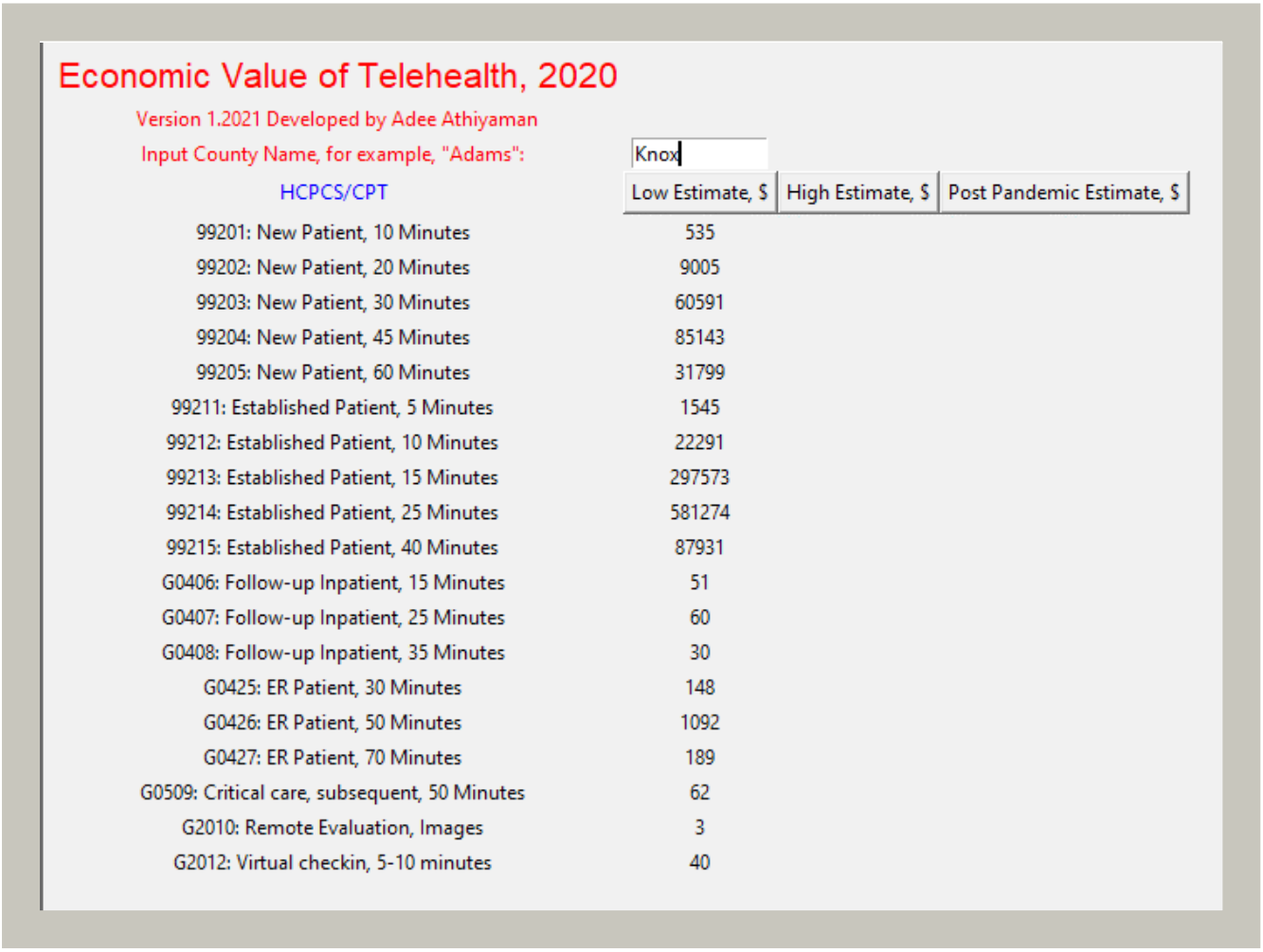


For county level estimates of value, the software TMC can be used. The software can be downloaded from the author's website, free of charge.

To illustrate, the software opens to the screen:



On entering “Knox” in the county box and clicking on the “Low Estimate, $” button would produce the following results:



Economic Value of Telehealth, 2020

Version 1.2021 Developed by Adee Athiyaman

Input County Name, for example, "Adams": Knox

HCPCS/CPT	Low Estimate, $	High Estimate, $	Post Pandemic Estimate, $
99201: New Patient, 10 Minutes	535		
99202: New Patient, 20 Minutes	9005		
99203: New Patient, 30 Minutes	60591		
99204: New Patient, 45 Minutes	85143		
99205: New Patient, 60 Minutes	31799		
99211: Established Patient, 5 Minutes	1545		
99212: Established Patient, 10 Minutes	22291		
99213: Established Patient, 15 Minutes	297573		
99214: Established Patient, 25 Minutes	581274		
99215: Established Patient, 40 Minutes	87931		
G0406: Follow-up Inpatient, 15 Minutes	51		
G0407: Follow-up Inpatient, 25 Minutes	60		
G0408: Follow-up Inpatient, 35 Minutes	30		
G0425: ER Patient, 30 Minutes	148		
G0426: ER Patient, 50 Minutes	1092		
G0427: ER Patient, 70 Minutes	189		
G0509: Critical care, subsequent, 50 Minutes	62		
G2010: Remote Evaluation, Images	3		
G2012: Virtual checkin, 5-10 minutes	40		

Similarly, the upper value can be obtained by clicking on the “High Estimate, $” button. The software also provides estimates of post-pandemic values for each of the 19 programs. This calculation assumes that only people who report a higher subjective utility for telemedicine over traditional healthcare would patronize the service post-Covid-19. For Knox County, post-pandemic estimates are approximately 50% of the high, 2020 values.

Economic Value of Telehealth, 2020

Version 1.2021 Developed by Adee Athiyaman

Input County Name, for example, "Adams": Knox

HCPCS/CPT	Low Estimate, $	High Estimate, $	Post Pandemic Estimate, $
99201: New Patient, 10 Minutes	535	1765	834
99202: New Patient, 20 Minutes	9005	29629	13934
99203: New Patient, 30 Minutes	60591	199308	93659
99204: New Patient, 45 Minutes	85143	280202	131694
99205: New Patient, 60 Minutes	31799	104628	49198
99211: Established Patient, 5 Minutes	1545	5079	2384
99212: Established Patient, 10 Minutes	22291	73342	34476
99213: Established Patient, 15 Minutes	297573	979011	460128
99214: Established Patient, 25 Minutes	581274	1912375	898801
99215: Established Patient, 40 Minutes	87931	289252	135943
G0406: Follow-up Inpatient, 15 Minutes	51	187	83
G0407: Follow-up Inpatient, 25 Minutes	60	201	100
G0408: Follow-up Inpatient, 35 Minutes	30	90	30
G0425: ER Patient, 30 Minutes	148	475	237
G0426: ER Patient, 50 Minutes	1092	3656	1723
G0427: ER Patient, 70 Minutes	189	567	252
G0509: Critical care, subsequent, 50 Minutes	62	124	62
G2010: Remote Evaluation, Images	3	19	7
G2012: Virtual checkin, 5-10 minutes	40	137	66

Summary and Conclusion

A common goal of healthcare systems is to generate the biggest impact on the largest number of people at the lowest possible cost; telemedicine has been shown to contribute positively to this goal (IBIS Industry Report, OD 5775). While case studies of the value of telemedicine abound[29], little or no research has examined the value of telemedicine at the county level. This paper fills this gap in knowledge, it estimates the economic value of telemedicine for Illinois counties using CMS data.

To achieve this task, a series of operations were performed. First, based on the prospect theory for risky choice, the subjective utility of telemedicine for the population was modeled; the results suggest (1) that people with little or no access

[29] See for example, Scott et al (2017). Perceived sustainability of community tele pharmacy in North Dakota, *Journal of the American Pharmacists Association*, 57, 362-368.

to ICT are reluctant to depart from the status quo, switch to telemedicine from traditional healthcare and (2) one's preference for telemedicine is independent of one's household income.

Next, telemedicine use in the counties were enumerated for 19 programs; the ACS 2019, 5-year estimates of Medicare beneficiaries in the counties were combined with CMS' 2019 Part B Carrier Summary data to arrive at the figures. Finally, forecasts of number of users of telemedicine were developed and combined with cost savings attributable to telemedicine to arrive at the economic value of telemedicine.

The outcomes of value computations suggest that in 2020, the value of telemedicine for Illinois was $1.76bil; almost seven times more than the 2019 value of $242.24 mil. Scenario analysis of post-pandemic situations suggests that the value or usage of telemedicine could decline by 47% to 52%; this is because, patients want to see their own physician, for example, PCP, when the need for healthcare arises and direct-to-consumer telemedicine firms such as Teladoc cannot meet this need (Portony, 2020).

Limitations of this research include (1) a focus on efficiency or technology outcomes rather than health status outcomes, for example, Quality Adjusted Life Year (QALY); and (2) using published data at the macro level (for example, state of IL numbers for telemedicine usage), to infer meso values (for example, proportional allocation of telemedicine usage to counties). On the latter, efforts are underway to purchase individual-level data for the geographies from the CMS.

In conclusion, this research can be labeled "satisficing", not actual numbers but estimates of the economic value of telemedicine for Illinois counties. However, given the face validity of our concepts and methods, the estimated 'values' are good representation of reality.

References

Athiyaman, A. (2021a). Consumer awareness of telemedicine during the Covid-19 pandemic. *Research Brief*, 3(1), 1-5. Available online: http://www.iira.org/wp-content/uploads/2020/06/Opiod_2020_draft.pdf.

Athiyaman, A. (2021b). Who uses telemedicine? *Research Brief*, 2(2), 1-6. Available online: http://www.iira.org/wp-content/uploads/2021/01/who_uses_telemedicine_v3_2_2021.pdf

Bergmo TS, Kummervold PE, Gammon D, Dahl LB (2005). Electronic patient-provider communication: Will it offset office visits and telephone consultations in primary care? International Journal of Medical Information, 74, 705–710.

IBISWorld (2020). *Industry Outlook: Telehealth Services,* OD5775, August.

Kahneman, D., and Tversky, A. (1979). Prospect theory: an analysis of decision under risk. *Econometrica*, 47, 263-291.

Labiris G, Tsitlakidis C, Niakas D. (2005). Retrospective economic evaluation of the Hellenic Air Force Teleconsultation Project. *J Med Syst*, 29(5), 493-500.

McCue MJ, Mazmanian PE, Hampton CL, Marks TK, Fisher EJ, Parpart F, et al. (1998). Cost-minimization analysis: a follow-up study of a telemedicine program. *Telemed J,* 4(4), 323-327

Paré G, Sicotte C, St-Jules D, Gauthier R. (2006). Cost-minimization analysis of a telehomecare program for patients with chronic obstructive pulmonary disease. *Telemed J E Health*, 12(2), 114-121.

Portony, J. (2020). Telemedicine in the era of Covid-19. *Journal of Allergy, Clinical Immunology and Practice*, 8(5), 1489-1491.

Reed, M. E., Huang, J., Graetz, I., Lee, C., Muelly, E., Kennedy, C., & Kim, E. (2020). Patient Characteristics Associated With Choosing a Telemedicine Visit vs Office Visit With the Same Primary Care Clinicians. *JAMA network open*, *3*(6), e205873. https://doi.org/10.1001/jamanetworkopen.2020.5873

Seehusen, D., and Azrak, A. (2019). The effectiveness of outpatient telehealth consultations. *American Family Physician*, 100(9), 575-577.

Xu, C. Q., Smith, A. C., Scuffham, P. A., & Wootton, R. (2008). A cost minimisation analysis of a telepaediatric otolaryngology service. *BMC Health Services Research*, *8*(1), 1-10.

Appendix 1: Awareness about Telemedicine: During the Covid-19 Pandemic and Pre-Pandemic

	Midwest Fall_2020	Midwest Summer_2020	Northeast Fall_2020	Northeast Summer_2020	South Fall_2020	South Summer_2020	West Fall_2020	West Summer_2020
Aware, During Covid-19	1,058,245	571,636	1,014,339	662,962	1,993,382	1,160,905	1,514,810	794,409
Aware, Pre-Covid-19	2,964,597	1,955,201	2,387,367	1,425,851	5,193,929	3,141,416	3,335,424	1,840,633
Total	4,022,841	2,526,837	3,401,707	2,088,813	7,187,311	4,302,322	4,850,234	2,635,042

	Midwest Fall_2020	Midwest Summer_2020	Northeast Fall_2020	Northeast Summer_2020	South Fall_2020	South Summer_2020	West Fall_2020	West Summer_2020
Use of Telemedicine								
Yes	1,919,427	1,213,347	1,494,050	878,522	3,179,284	1,955,236	2,069,656	1,172,090
No	2,103,414	1,313,490	1,907,657	1,210,291	4,009,903	2,347,086	2,780,579	1,462,952
Total	4,022,841	2,526,837	3,401,707	2,088,813	7,189,187	4,302,322	4,850,234	2,635,042

Appendix 2: Changes in Telemedicine Use among the Medicare Population in Illinois, Some Examples

HCPCS Level II Codes	Description	% Change, 2015-2019	N, 2015	N, 2019
G0406	Follow-up inpatient consultation, limited, physicians typically spend 15 minutes communicating with the patient via telehealth	3376%	25	869
G0407	Follow-up inpatient consultation, intermediate, physicians typically spend 25 minutes communicating with the patient via telehealth	3762%	13	502
G0408	Follow-up inpatient consultation, complex, physicians typically spend 35 minutes communicating with the patient via telehealth	36%	39	144
G0425	Telehealth consultation, emergency department or initial inpatient, typically 30 minutes communicating with the patient via telehealth	360%	42	192
G0426	Telehealth consultation, emergency department or initial inpatient, typically 50 minutes communicating with the patient via telehealth	280%	70	266
G0427	Telehealth consultation, emergency department or initial inpatient, typically 70 minutes or more communicating with the patient via telehealth	140%	40	96

Appendix 3: Measures from MCBS, Fall 2020, Covid-19 Supplement

	Measure	
Concept	**Survey Question**	**Response Option**
Telemedicine use behavior	Does your usual provider offer telephone or video appointments, so that [you don't/he/she doesn't] need to physically visit their office or facility?	(01) YES (02) NO (-8) DON'T KNOW (-7) REFUSED
ICT Access	Do you own or use any of the following types of computers? Please tell me yes or no for each item I list. **COMPDESK.** Desktop or laptop **COMPPHON.** Smartphone **COMPTAB.** Tablet or other portable wireless computer. Do you have access to the Internet? Since July 2020, have you participated in video or voice calls or conferencing over the internet, such as with Zoom, Skype, or FaceTime?	(01) YES (02) NO (-8) DON'T KNOW (-7) REFUSED
Attitude towards telemedicine	Since July 2020, have you done any of the following in response to the outbreak of the new coronavirus? (01) Cleaned or sterilized commonly-touched surfaces, such as door knobs (02) Kept a six-foot distance between yourself and people outside your household (03) Avoided large groups of people (04) Left home for essential purposes only, such as for medical appointments or grocery shopping, sometimes called "sheltering in place" (05) Avoided touching your face (06) Worn a facemask when out in public.	(01) YES (02) NO (03) UNABLE DUE TO SHORTAGES (04) NOT APPLICABLE (-8) DON'T KNOW (-7) REFUSED

Appendix 4: Healthcare Common Procedure Coding System (HCPCS) and Current Procedural Terminology (CPT) Codes

Code	Service
99201	Office or other outpatient visits, 10 minutes
99202	Office or other outpatient visits, 20 minutes
99203	Office or other outpatient visits, 30 minutes
99204	Office or other outpatient visits, 45 minutes
99205	Office or other outpatient visits, 60 minutes
99211	Office or other outpatient visits
99212	Established Patient Office or Other Outpatient Visit, Typically 10 Minutes
99213	Established Patient Office or Other Outpatient Visit, Typically 15 Minutes
99214	Established Patient Office or Other Outpatient Visit, Typically 25 Minute
99215	Office or other outpatient visits
G0406	Follow-up inpatient consultation, limited, physicians typically spend 15 minutes communicating with the patient via telehealth
G0407	Follow-up inpatient consultation, intermediate, physicians typically spend 25 minutes communicating with the patient via telehealth
G0408	Follow-up inpatient consultation, complex, physicians typically spend 35 minutes communicating with the patient via telehealth
G0425	Telehealth consultation, emergency department or initial inpatient, typically 30 minutes communicating with the patient via telehealth
G0426	Telehealth consultation, emergency department or initial inpatient, typically 50 minutes communicating with the patient via telehealth
G0427	Telehealth consultation, emergency department or initial inpatient, typically 70 minutes or more communicating with the patient via telehealth
G0509	Telehealth consultation, critical care, subsequent, physicians typically spend 50 minutes communicating with the patient and providers via telehealth
G2010	Remote evaluation of images
G2012	Virtual Check-in

Appendix 5: Number of Telemedicine Users in Rural Illinois, by Program, 2019 Estimates

NAME	99201	99202	99203	99204	99205	99211	99212	99213	99214	99215	G0406	G0407	G0408	G0425	G0426	G0427	G0509	G2010	G2012
Adams	67	641	2,717	2,427	694	486	2,751	20,838	25,948	2,870	5	3	1	1	2	1	0	0	2
Brown	5	49	208	186	53	37	211	1,595	1,986	220	0	0	0	0	0	0	0	0	0
Bureau	38	359	1,523	1,360	389	273	1,542	11,679	14,543	1,608	3	2	0	1	1	0	0	0	1
Carroll	18	173	733	655	187	131	742	5,623	7,002	774	1	1	0	0	0	0	0	0	1
Cass	11	107	456	407	116	82	461	3,494	4,350	481	1	1	0	0	0	0	0	0	0
Christian	32	309	1,308	1,169	334	234	1,325	10,033	12,494	1,382	3	2	0	1	1	0	0	0	1
Clark	16	155	658	588	168	118	666	5,048	6,286	695	1	1	0	0	0	0	0	0	0
Clay	14	138	586	523	150	105	593	4,491	5,592	618	1	1	0	0	0	0	0	0	0
Coles	43	412	1,748	1,561	447	313	1,770	13,405	16,692	1,846	4	2	0	1	1	0	0	0	1
Crawford	18	167	707	631	181	127	716	5,420	6,749	746	1	1	0	0	0	0	0	0	1
Cumberland	11	103	438	391	112	78	443	3,356	4,180	462	1	1	0	0	0	0	0	0	0
Douglas	20	188	797	712	204	143	806	6,109	7,607	841	2	1	0	0	0	0	0	0	1
Edgar	20	188	795	711	203	142	805	6,100	7,596	840	2	1	0	0	0	0	0	0	1
Edwards	7	66	281	251	72	50	285	2,157	2,686	297	1	0	0	0	0	0	0	0	0
Effingham	31	293	1,242	1,109	317	222	1,257	9,524	11,860	1,312	2	1	0	1	1	0	0	0	1
Fayette	20	194	824	736	211	148	834	6,320	7,870	870	2	1	0	0	1	0	0	0	1
Franklin	38	365	1,548	1,383	396	277	1,567	11,873	14,785	1,635	3	2	0	1	1	0	0	0	1
Fulton	34	327	1,385	1,237	354	248	1,402	10,621	13,225	1,463	3	2	0	1	1	0	0	0	1
Gallatin	6	54	230	205	59	41	233	1,764	2,196	243	0	0	0	0	0	0	0	0	0
Greene	14	135	574	513	147	103	581	4,404	5,484	607	1	1	0	0	0	0	0	0	0
Hamilton	9	86	365	326	93	65	369	2,797	3,482	385	1	0	0	0	0	0	0	0	0
Hancock	23	217	919	821	235	165	931	7,049	8,777	971	2	1	0	0	1	0	0	0	1
Hardin	6	52	222	199	57	40	225	1,705	2,123	235	0	0	0	0	0	0	0	0	0
Henderson	9	82	346	309	88	62	350	2,653	3,304	365	1	0	0	0	0	0	0	0	0
Iroquois	31	296	1,254	1,121	320	225	1,270	9,619	11,978	1,325	3	1	0	1	1	0	0	0	1
Jasper	10	96	408	364	104	73	413	3,128	3,895	431	1	0	0	0	0	0	0	0	0
Jefferson	34	326	1,383	1,235	353	248	1,400	10,606	13,207	1,461	3	2	0	1	1	0	0	0	1
Jo Daviess	34	321	1,361	1,216	348	244	1,378	10,439	12,999	1,438	3	2	0	1	1	0	0	0	1
Johnson	13	121	515	460	132	92	521	3,948	4,916	544	1	1	0	0	0	0	0	0	0
Knox	52	495	2,098	1,874	536	376	2,124	16,087	20,032	2,216	4	2	0	1	1	0	0	0	2
LaSalle	106	1,011	4,285	3,828	1,095	767	4,339	32,865	40,925	4,526	9	5	1	2	3	1	0	0	3
Lawrence	15	147	623	557	159	112	631	4,780	5,952	658	1	1	0	0	0	0	0	0	0
Lee	33	317	1,345	1,202	344	241	1,362	10,316	12,846	1,421	3	2	0	1	1	0	0	0	1
Livingston	36	339	1,438	1,284	367	257	1,456	11,026	13,730	1,519	3	2	0	1	1	0	0	0	1
Logan	25	239	1,013	905	259	181	1,025	7,767	9,672	1,070	2	1	0	0	1	0	0	0	1
Marion	34	324	1,373	1,226	351	246	1,390	10,528	13,109	1,450	3	2	0	1	1	0	0	0	1
Mason	15	146	621	555	159	111	629	4,761	5,929	656	1	1	0	0	0	0	0	0	0
Massac	15	146	618	552	158	111	626	4,740	5,902	653	1	1	0	0	0	0	0	0	0
McDonough	25	237	1,005	898	257	180	1,018	7,710	9,601	1,062	2	1	0	0	1	0	0	0	1
Montgomery	29	272	1,153	1,030	295	206	1,167	8,840	11,008	1,217	2	1	0	1	1	0	0	0	1
Morgan	33	311	1,320	1,179	337	236	1,336	10,120	12,602	1,394	3	2	0	1	1	0	0	0	1
Moultrie	12	117	497	444	127	89	503	3,811	4,745	525	1	1	0	0	0	0	0	0	0
Ogle	49	466	1,975	1,765	505	354	2,000	15,149	18,864	2,086	4	2	0	1	1	0	0	0	1
Perry	21	196	833	744	213	149	843	6,385	7,951	879	2	1	0	0	1	0	0	0	1
Pike	16	156	662	592	169	119	671	5,080	6,326	700	1	1	0	0	0	0	0	0	0
Pope	6	59	251	224	64	45	254	1,924	2,396	265	1	0	0	0	0	0	0	0	0
Pulaski	6	57	241	215	62	43	244	1,848	2,301	255	0	0	0	0	0	0	0	0	0
Putnam	7	65	278	248	71	50	281	2,129	2,651	293	1	0	0	0	0	0	0	0	0
Randolph	30	284	1,206	1,077	308	216	1,221	9,245	11,513	1,273	2	1	0	1	1	0	0	0	1
Richland	15	144	613	547	157	110	620	4,698	5,850	647	1	1	0	0	0	0	0	0	0
Saline	21	198	837	748	214	150	848	6,421	7,996	884	2	1	0	0	1	0	0	0	1
Schuyler	7	64	272	243	69	49	275	2,085	2,596	287	1	0	0	0	0	0	0	0	0
Scott	5	46	196	175	50	35	199	1,504	1,873	207	0	0	0	0	0	0	0	0	0
Shelby	26	252	1,067	953	273	191	1,081	8,185	10,192	1,127	2	1	0	0	1	0	0	0	1
Stephenson	52	500	2,119	1,893	542	379	2,146	16,254	20,240	2,239	4	2	0	1	1	0	0	0	2
Union	18	170	722	645	185	129	731	5,541	6,899	763	1	1	0	0	0	0	0	0	1
Wabash	11	109	463	414	118	83	469	3,553	4,424	489	1	1	0	0	0	0	0	0	0
Warren	17	159	674	602	172	121	682	5,169	6,436	712	1	1	0	0	0	0	0	0	1
Washington	15	141	599	535	153	107	607	4,594	5,721	633	1	1	0	0	0	0	0	0	0
Wayne	19	179	761	680	194	136	770	5,834	7,265	804	2	1	0	0	0	0	0	0	1
White	16	149	632	564	161	113	640	4,846	6,034	667	1	1	0	0	0	0	0	0	0
Whiteside	62	591	2,506	2,238	640	449	2,537	19,215	23,928	2,646	5	3	1	1	2	1	0	0	2