The Effects of the COVID-19 Pandemic on the Digital Divide in the United States

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Abstract

The digital divide has emerged as a significant social issue that impedes the development of productivity and equality with the growth of the internet. The outbreak of COVID-19 in 2020 has further enhanced the importance of the internet. This study focuses on whether the digital divide has worsened or improved due to the pandemic. The research employs the Difference-in-Differences (DID) and a logistic regression to investigate the internet usage gap between urban and rural residents in the United States. This study reveals that the pandemic has reduced the digital divide between urban and rural areas. Additionally, the study finds that urban residents, women, younger individuals, and those with higher education are more likely to consider high-speed internet to be more essential during the pandemic.

1. Introduction

Since the rise of the internet era, various types of digital divide issues have persisted, such as internet information disparities based on urban-rural, age, and educational levels. The digital divide is a social differentiation issue caused by gaps in information and technology ownership, application, and innovation capabilities among various groups of people within a country, and it may deepen into a social justice problem as the gap widens. Starting in 2020, the COVID-19 pandemic has significantly affected people's daily lives, work, education, and health worldwide. Especially, the health risks of COVID-19 have led to a large amount of home isolation, online work, and remote education, which further increased people's demand for the internet during this period. Did this increase in demand affect the digital divide among different social classes, thus alleviating the digital divide issue? This paper aims to investigate how the occurrence of COVID-19 has affected the digital divide in the United States. I will explore this question in two parts. In the first part, by comparing the differences in internet usage between urban and rural areas before and after the pandemic, I will explore how the pandemic has affected the internet access disparity and social media usage gap between urban and rural areas. In the second part, this article will focus on exploring people's attitudes and needs towards the internet during the pandemic in order to investigate whether vulnerable groups continue to be disadvantaged in the context of the COVID-19 pandemic.

This study uses data from the Pew Research Center, selecting databases related to internet usage in the United States. By using the Difference-in-Differences (DID) empirical method, I explore whether the COVID-19 pandemic has affected urban-rural internet access. Specifically, I analyze internet usage, household internet service subscriptions, mobile internet usage, and the usage of high-speed broadband services in 2018, 2019, and 2021. The main conclusion is that the COVID-19 pandemic had an impact on the urban-rural internet usage gap, reducing it by approximately 6%. I also pay attention to the gap in internet usage

behavior between urban and rural areas during the pandemic, which helps me to identify whether the digital divide problem in urban-rural areas has been alleviated due to COVID-19. I select social media usage in urban and rural areas from 2018 to 2021 and analyze usage of seven different social media applications. I found that the usage gap of social media has decreased by approximately 5% due to the pandemic and that there has been a trend towards reduced urban-rural usage gaps in certain social media applications. In addition to the analysis of usage rates, this paper focuses on the attitudes of different demographic characteristics towards internet use during the pandemic. By using Ordinal Logistic Regression (OLR), I explore which demographic characteristics are more likely to value informational internet activities and communication internet activities during the pandemic. My findings indicate that disadvantaged groups, such as rural residents, older individuals, and those with lower levels of education, still do not place as much importance on the internet during the pandemic compared to advantaged groups. This may be a contributing factor to the continued existence of the internet usage gap and its potential to widen in the future.

Through the exploration of the impact of the COVID-19 pandemic on the digital divide, as well as the characteristics of the population that pay attention to internet activities during the pandemic, this paper can provide guidance for decision-makers in the information technology and public safety industries. This is beneficial for inspiring solutions to address the digital divide and promote social information equity in the future.

2. Literature Review

Digital Divide and COVID-19

The definition of digital divide in this research is the gap between demographic groups and regions that have access to modern information and communications technology and those that don't (Taylor 2022). The technology encompassing telephones, televisions, personal computers, and internet connectivity has been the subject of the digital divide. Prior to the late 20th century, this divide centered on the access to telephones. However, with the advent of the internet and its increasing significance, the digital divide has shifted to refer to the gap between those with and without internet access, particularly broadband, since the late 1990s (Hanna 2021).

The existence of digital divides has been confirmed across various dimensions, as identified by Unwin and De Bastion (2009), including social, geographical, and economic factors. Through studies such as those conducted by Kady and Vadeboncoeur (2013) and Matuchniak and Warschauer (2010), it has been established that access to technology and the necessary skills for its utilization (such as devices, information, and the internet) vary significantly across different groups of individuals due to differences in education, geographic location, age, ethnicity, and income.

The use of digital technologies and media by the general population has undergone massive and unprecedented changes as a result of the COVID-19 pandemic (Guitton 2020). Previously considered a non-essential amenity, virtual digital spaces have become a crucial necessity due to the global lockdowns that have disrupted essential social connections. Given the limitations on interpersonal interactions during COVID-19 quarantines, the use of digital technologies has become indispensable, and alternatives for even routine tasks are scarce (Beaunoyer, Dupéré, and Guitton 2020).

Urban-Rural Digital Divide

The issue of limited or nonexistent internet access in rural areas has persisted for years (Vogels 2021). This issue has become particularly acute during the COVID-19 pandemic, when internet access has become a compulsory requirement for many people. The lack of adequate internet connectivity and services in rural areas has created several challenges, including brain drain of talent, skills, training and development, limited access to telemedicine, and difficulties with distance learning (Hennessy, Läpple, and Moran 2016; Thompson 2020). Furthermore, the inability to use precision agriculture technology and data in farm and rural industries is also a challenge (Smith 2020). Although internet speed is a common challenge for many rural residents, a significant number of individuals still lack access to any internet connection, without resorting to costly and cumbersome satellite or other options. According to the Federal Communications Commission (FCC) in 2020, only 51.6% of rural US residents had 250/25 Mbps internet access in 2018, compared to 94% of urban residents. This broadband speed is deemed moderate usage by the FCC and could support a household with four devices (FCC 2022).

According to the Pew Research Center (2021), approximately seven out of ten rural residents in the United States reported having access to broadband internet. The broadband usage rate among rural residents remains lower than that of urban residents (Vogels 2021). Despite an increase in wired networks in rural areas, the current infrastructure does not support reliable broadband access in many regions (Wiltermuth 2021). The lack of reliable high-speed internet access has become a focal point in discussions surrounding remote work and education during the COVID-19 pandemic (Whitacre and Gallardo 2020). It is evident that the pandemic has had an impact on the rural-urban digital divide. However, there is currently a little of quantitative research comparing the changes in internet usage disparities between urban and rural areas before and after the pandemic.

Socio-demographic categories and Internet usage

There are several socio-demographic variables that explain individual differences in internet use. Several studies suggest gender differences (Meraz 2008; Zillien and Hargittai 2009). There is, for example, evidence that adult females are more likely to use the internet's communication tools (Fallows 2005), and adult females tend to rely more on the internet as a source of health information compared to adult males (Liu and Wang 2020). Age has been identified as one of the most influential factors affecting internet use (Zillien and Hargittai, 2009), with young adults being the primary users of communication tools, such as instant messaging and chatting, and engaging in leisure activities such as downloading music or browsing for entertainment purposes (Blank, Dutton, and Lefkowitz 2020).

Socio-economic status is also a crucial factor in internet use (Zillien and Hargittai, 2009). DiMaggio et al. (2004) argued that individuals from higher socio-economic backgrounds tend to use the internet more effectively and gain greater economic benefits than their less privileged peers who are still connected. It has also been observed that individuals with lower socio-economic status tend to use the internet for general and superficial purposes (Van Dijk 2023). Socio-economic status is a multidimensional concept that encompasses factors such as educational attainment, employment status, and income. Liu and Wang found that individuals with higher levels of education tend to rely more on the internet for obtaining health information in 2020. Additionally, individuals with higher incomes are more likely to use the internet, as reported by the U.S. Department of Health and Human Services (Swenson and Ghertner 2020).

3. Empirical Strategy

In the first part, I examine two hypotheses: (1) COVID-19 pandemic has a negative impact on internet access gap in urban-rural areas. (2) The social media usage gap in urban-rural areas has increased due to COVID-19. To test these hypotheses, I employ Difference-in Differences (DID) method:

$$Y_i = \beta_0 + \beta_1 Urban_i + \beta_2 COVID\_Time_i + \beta_3 Urban_i \times COVID\_Time_i + \varepsilon_i$$

$Urban_i$ is a dummy variable showing whether each individual resides in an urban areas (1: Urban, 0: Rural). In this study, the population of urban residents is defined as greater than 250,000. $COVID\_Time_i$ is also a dummy variable and it will indicate 1 when it is a 2020 and after case, while it will show 0 when it is 2019 and before. I consider five different internet-related dependent variables. For hypothesis (1), $IntUse_i$ measures the percentage of people using the internet or email at least occasionally. $IntSub_i$ measures the portion of residents currently subscribe to internet service at home. $MobIntUse_i$ measures the proportion of residents accessing the internet on mobile handheld device at least occasionally. $BBUse_i$ measures the share of people using high-speed broadband instead of low-speed dial-up. In terms of hypothesis (2), $SocialMedia_i$ will be employed to measure the ratio of people using at least one social media application. Furthermore, I recognize percentages of people using Twitter, Instagram, Facebook, Snapchat, YouTube, WhatsApp, and LinkedIn individually as dependent variables, and did 7 DID regressions to check if the social media apps usage gap has been changed due to COVID-19.

The coefficient of the DID estimator is an important criterion for testing the validity of my hypothesis. If the DID coefficient is negative and statistically significant, it indicates that the urban-rural gap in the dependent variable has decreased due to the COVID-19 outbreak, thus supporting my hypothesis. However, for the DID estimator to be valid, the

parallel trend assumption must hold, which requires that the control and treatment groups have parallel trends in the dependent variable before the policy intervention. In the study, the outbreak of the COVID-19 epidemic serves as the "policy intervention", with urban residents as the treatment group and rural residents as the control group. Therefore, it is necessary to ensure that the dependent variable trends of urban and rural residents were parallel before the outbreak of the epidemic. I can then compare the dependent variable trends after the outbreak of the epidemic in urban and rural areas to determine whether the urban-rural gap in the dependent variable has decreased or expanded.

The second part of this study aims to investigate the demographic factors that influence informational internet activities and communication internet activities during the COVID-19 pandemic. To achieve this objective, Ordinal Logistic Regression (OLR) analysis was employed:

$$logit(\hat{P}(Y \leq j)) = \beta_{j0} - \eta_1 A - \eta_2 G - \eta_3 E - \eta_4 I - \eta_5 W - \eta_6 U$$

A represents the age, G shows the gender, E is the education level, I represents income status, W displays the employment status, and U indicates the living region of each individual. I let Y be an ordinal outcome indicating how important each individual thinks high-speed internet is for informational internet activities or communication internet activities with $J = 3$ categories: 1: not important, 2: somewhat important, 3: very important. This statistical technique enables the identification of the impact of demographic variables on the two types of internet activities, namely informational and communication. By using OLR, I can effectively analyze the impact of various demographic variables, such as age, gender, and education level, on the likelihood of engaging in different types of internet activities. To perform the analysis using OLR, it is necessary to assume that each type of informational and communication internet activity is independent of each other. For predictor variables that

have statistically significant effects on the outcome, odds ratios will be calculated to determine what demographic variables effect on the probability of participating in the two types of internet.

4. Data

In the first part of this research, I will mainly be using three datasets provided by Core Trends Survey from Pew Research Center. These are cross-sectional social surveys related to internet and social media usage among adults aged 18 and above in the United States in 2018, 2019, and 2021. Due to the shutdown caused by the pandemic, the Pew Research Center did not conduct the Core Trends Survey in 2020. All of the surveys were conducted around January and February in each corresponding year. To use Difference-in-Differences, I combine them into a panel dataset. I have four dependent variables, internet use rate (n=4,654), internet subscription rate (n=4,449), mobile internet use rate (n=4,651), and broadband use rate(n=3,527). I got the living region information of each individual, dividing respondents into urban residents and rural residents. According to their interview time, the interview records in 2018 and 2019 were classified as pre-pandemic, while those conducted after that were classified as post-pandemic.

Table 1. Summary Statistics of Four Internet-related Models

	Internet Usage		**Household Internet**	
Variables:	N	Percent	N	Percent
COVID_Time:	4654		4449	
Pre-COVID(2018)	1854	39.8%	1655	37.2%
Pre-COVID(2019)	1397	30%	1394	31.3%
Post-COVID(2021)	1403	30.1%	1400	31.5%
Urban:	4654		4449	
Rural	823	17.7%	764	17.2%
Urban	3831	82.3%	3685	82.8%
	Mobile Internet Usage		**Broadband Usage**	
Variables:	N	Percent	N	Percent
COVID_Time:	4651		3527	
Pre-COVID(2018)	1851	39.8%	1303	36.9%
Pre-COVID(2019)	1396	30%	1084	30.7%
Post-COVID(2021)	1404	30.2%	1140	32.3%
Urban:	4651		3527	
Rural	822	17.7%	574	16.3%
Urban	3829	82.3%	2953	83.7%

Note: Data is from Pew Research Center. According to the notebook provided by Pew Research Center, urban areas have more than 250,000 people.

In the study of social media usage, I used data from the American Trends Panel survey on social media conducted by Pew Research Center in 2020, in addition to the three original databases. The survey respondents consisted of American individuals over the age of 18, and the interviews were conducted in early September. I obtained social media usage data for each respondent (n=14,756), as well as specific usage data for seven social media applications (n=13,284). I also collected information on each respondent's living region and categorized the data as pre- or post-pandemic based on the time of the interview.

Table 2. Summary Statistics of Models Related to Social Media

	Social Media Usage		Seven Social Media APPs Usage	
Variables:	N	Percent	N	Percent
COVID_Time:	14746		13284	
Pre-COVID(2018)	1851	12.6%	1377	10.4%
Pre-COVID(2019)	1398	9.5%	1779	13.4%
Post-COVID(2020)	10093	68.4%	8740	65.8%
Post-COVID(2021)	1404	9.5%	1388	10.4%
Urban:	14746		13284	
Rural	1943	13.2%	1789	13.5%
Urban	12803	86.8%	11495	86.5%

Note: Data from Pew Research Center

In the second part of the study, I employed the Core Trends Survey conducted by Pew Research Center in 2021. The dependent variable was the respondents' answers to the question, "Thinking about how people might use the internet during the COVID-19 pandemic. Do you think people who do NOT have high-speed internet access at home are…in the following activities?" The responses were ordinal variables: 1: not at a disadvantage, 2: at a minor disadvantage, and 3: at a major disadvantage. For ease of understanding, I modified the ordinal variables to 1: not important, 2: somewhat important, and 3: very important. In my analysis, I categorized "Getting the latest information about COVID-19" and "Looking for jobs" as informational internet activities, and "Staying in contact with friends and family" and "Connecting with doctors or other medical professionals" as communicative internet activities. I collected demographic information of each respondent, including gender, employment status, living region, income, education level, and age. I categorized gender as male (1) or female (0), employment status as employed (1) or unemployed (0), living region as urban (1) or rural (0), income as 1: less than $30,000 per year, 2: $30,000 to $100,000 per year, or 3: over $100,000 per year, and education level as 1: less than high school, 2: high school incomplete, 3: high school graduate, 4: some college, no degree, 5: two-year associate degree from a college or

university, 6: four-year college or university degree/bachelor's degree, 7: some postgraduate or professional schooling, no postgraduate degree, or 8: postgraduate or professional degree.

Table 3. Summary Statistics of Informational/Communication Internet Use Models

Dependent Variables	N	Mean	SD	Min	Max
Informational Internet Use:					
Keeping up with the latest information about COVID-19	1086	2.315	0.734	1	3
Looking for jobs	1086	2.636	0.617	1	3
Communication Internet Use:					
Staying in contact with friends and family	1086	2.339	0.729	1	3
Connecting with doctors or other medical professionals	1086	2.418	0.71	1	3

Independent Variables	N	Mean	SD	Min	Max
Urban/Rural:	1086				
Rural	206	19%			
Urban	880	81%			
Sex:	1086				
Male	613	56.4%			
Female	473	43.6%			
Employment Status:	1086				
Employed	813	74.9%			
Unemployed	273	25.1%			
Age	1086	50.139	18.024	18	97
Education Level	1086	5.288	1.869	1	8
Income Level	1086	2.122	0.72	1	3

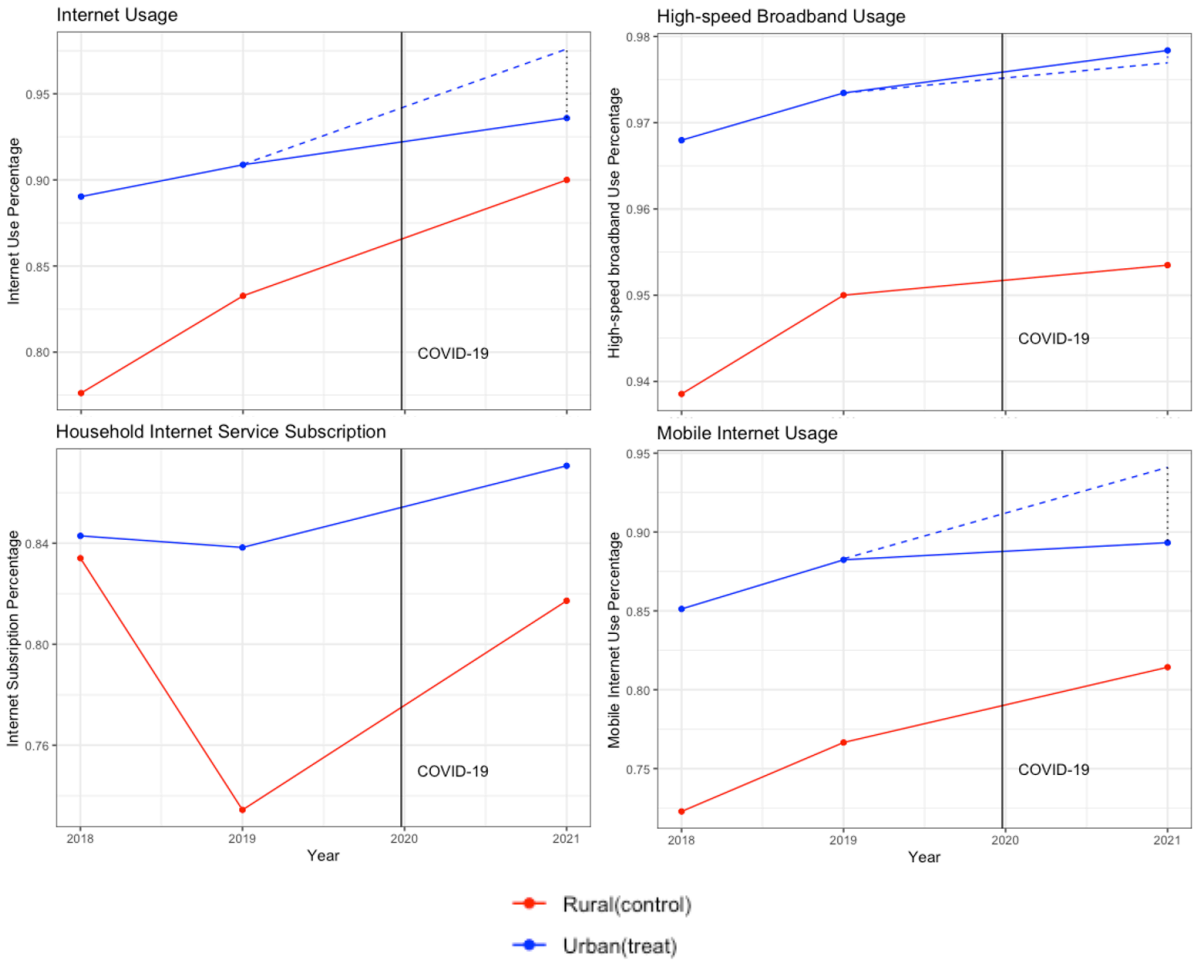
Note: Data from Pew Research Center

5. Findings

In the first stage, I employed DID in order to determine whether the urban-rural gap in internet-related disparities has decreased due to the COVID-19 pandemic. Prior to this, I first need to determine whether the trends of the control group and the treatment group before the outbreak of the pandemic were parallel. The parallel trends assumption is important because it reduces potential biases and confounding factors, increasing the reliability of the causal estimates derived from the DID method. If the parallel trends assumption does not hold, the estimates from the DID method may be biased and fail to provide a valid covariance between

the treatment indicator and the error term. From Figure 1, I can observe that three of the dependent variables, except for household internet subscriptions, roughly conform to the DID parallel assumption. In Table 4, I found that only when the dependent variable is internet usage and the DID coefficient is statistically significant and negative, does this indicate that the urban-rural gap in internet usage has decreased by approximately 6% due to the COVID-19 pandemic.

Figure 1. Graphical Diagnostic of Parallel Trends in Four Internet-related Models



Note: Data from Pew Research Center

Table 4. Difference-in-Differences Estimates of Four Internet-related Models

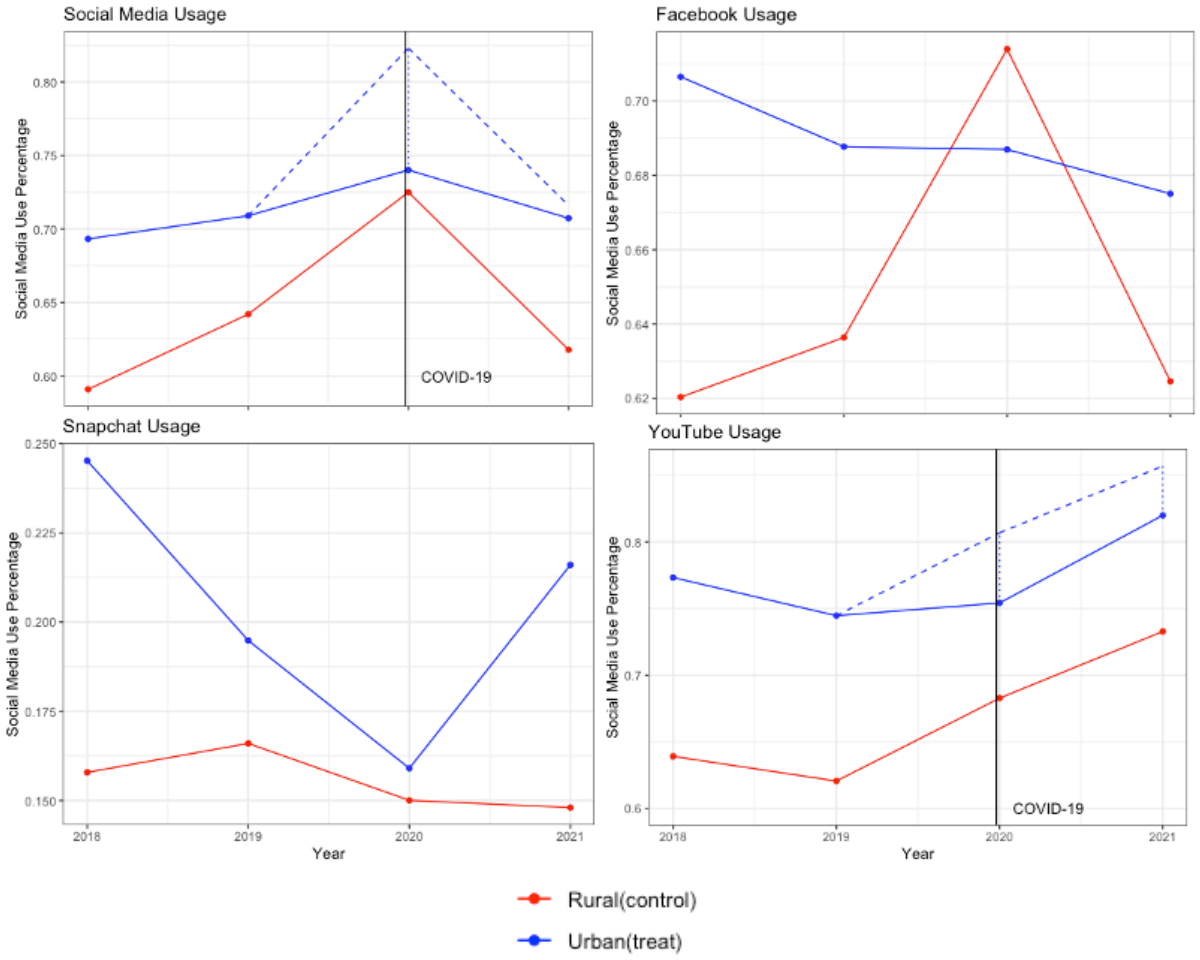
	Dependent variable:			
	Access Rate			
	Internet Use	Internet Subscription	Mobile Internet Use	Broadband Use
	(1)	(2)	(3)	(4)
During COVID-19	0.097***	0.036	0.071***	0.009
	(0.022)	(0.027)	(0.026)	(0.015)
Urban	0.095***	0.059***	0.121***	0.026***
	(0.014)	(0.018)	(0.016)	(0.010)
DID	−0.059**	−0.006	−0.042	−0.001
	(0.025)	(0.030)	(0.029)	(0.016)
Intercept	0.803***	0.781***	0.744***	0.944***
	(0.013)	(0.017)	(0.015)	(0.009)
Observations	4,654	4,449	4,651	3,527
R^2	0.015	0.005	0.016	0.003
Adjusted R^2	0.014	0.004	0.015	0.002

*Note: *p<0.1; **p<0.05; ***p<0.01. Data from Pew Research Center*

In the study of the urban-rural gap in social media usage, Figure 2 shows that the trend of social media usage among urban and rural residents before the COVID-19 pandemic tended to be parallel. At the same time, in Table 5, I also found that the DID coefficient was -0.052 and statistically significant. Therefore, the urban-rural gap in social media usage has decreased by approximately 5% due to the pandemic.

I also conducted DID on the urban-rural usage rates of seven different social media apps and found that only the DID coefficients of Facebook, Snapchat, and YouTube were statistically significant, as shown in Table 5. I then checked their parallel assumptions, as shown in Figure 2, and found that only the urban-rural usage of YouTube had a parallel trend before the pandemic. Therefore, I can conclude that the urban-rural gap in YouTube usage has decreased by approximately 6.2% due to the COVID-19 pandemic.

Figure 2. Graphical Diagnostic of Parallel Trends in Social Media Usage Model and Seven Social Media APPs Usage Models



Note: Data from Pew Research Center

Table 5. Difference-in-Differences Estimates of Seven Social Media APPs Usage Models and Social Media Usage Model

	Dependent variable:							
	Twitter	Instagram	WhatsApp	LinkedIn	Facebook	Snapchat	YouTube	Social Media Usage
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
During COVID-19	0.012	0.042*	−0.005	0.056**	0.066***	−0.012	0.064***	0.088***
	(0.023)	(0.025)	(0.021)	(0.024)	(0.024)	(0.020)	(0.022)	(0.023)
Urban	0.085***	0.128***	0.122***	0.169***	0.070***	0.062***	0.131***	0.085***
	(0.021)	(0.023)	(0.019)	(0.022)	(0.022)	(0.018)	(0.021)	(0.021)
DID	0.020	0.010	0.011	−0.015	−0.079***	−0.045**	−0.062**	−0.052**
	(0.025)	(0.027)	(0.023)	(0.026)	(0.026)	(0.022)	(0.024)	(0.025)
Intercept	0.160***	0.224***	0.102***	0.145***	0.628***	0.162***	0.630***	0.615***
	(0.019)	(0.021)	(0.018)	(0.020)	(0.020)	(0.017)	(0.019)	(0.019)
Observations	13,284	13,284	13,284	13,284	13,284	13,284	13,284	14,746
R^2	0.007	0.011	0.012	0.015	0.001	0.004	0.005	0.003
Adjusted R^2	0.007	0.011	0.012	0.015	0.001	0.004	0.005	0.003

*Note: *p<0.1; **p<0.05; ***p<0.01. Data is from Pew Research Center.*

In the second part, I employed OLR to identify the demographic variables that influence people's perceived importance of high-speed internet. As shown in Tables 7 and 8, the coefficients for living region, gender, age, and education level are statistically significant. Holding other factors constant, urban residents are 1.394 times more likely than rural residents to consider the internet as more important for obtaining COVID-19 information, and 1.6 times more likely to consider the internet as more important for finding a job during the pandemic. With regard to gender differences, holding other factors constant, females are 1.3 times more likely than males to consider the internet more helpful in obtaining pandemic information, and 1.8 times more likely to consider the internet more helpful in finding a job. Furthermore, younger individuals are more likely to perceive the internet as more important for informational activities. Holding other factors fixed, for every unit increase in age, people's perceived probability of the internet being more helpful in obtaining pandemic information decreases by 1.6%, and the perceived probability of the internet being more helpful in finding a job decreases by 1.3%. Additionally, holding other factors unchanged, for every increase in education level (e.g., from incomplete high school to high school completion), people's perceived probability of the internet being more important for obtaining pandemic information increases by 1.1 times and the probability of the internet being helpful in finding a job increases by 1.2 times.

Table 7. Ordinal Logistic Regression Estimates of Informational Internet Activities

	Dependent variable:	
	Getting latest info. about COVID-19	Looking for jobs
	(1)	(2)
Urban	0.332**	0.469***
	(0.146)	(0.163)
Gender	−0.281**	−0.598***
	(0.119)	(0.143)
Age	−0.016***	−0.013***
	(0.004)	(0.005)
Education	0.116***	0.189***
	(0.035)	(0.041)
Employment	0.130	0.175
	(0.167)	(0.192)
Income	−0.007	−0.066
	(0.090)	(0.105)
Intercepts:		
Not Important|Somewhat Important	−1.725***	−2.259***
	(0.357)	(0.422)
Somewhat Important|Very Important	0.088	−0.572
	(0.353)	(0.411)
Observations	1,086	1,086

*Note: *p<0.1; **p<0.05; ***p<0.01. Data is from Pew Research Center.*

Table 8. Odds Ratio of Informational Internet Activities Models

Predictor	Odds Ratio	p value
Urban	1.394	2.34e-02
Gender	0.755	1.81e-02
Age	0.984	7.79e-05
Education	1.123	9.68e-04
Employment	1.138	4.38e-01
Income	0.993	9.400e-01

Predictor	Odds Ratio	p value
Urban	1.599	4.046e-03
Gender	0.550	2.783e-05
Age	0.987	7.516e-03
Education	1.208	4.206e-06
Employment	1.192	3.609e-01
Income	0.936	5.294e-01

*Note: Data is from Pew Research Center. The left table displays the odds ratio of each independent variables in the model which sets **getting latest information about COVID-19** as the dependent variable, and the right one shows odds ratio in the model which sets **looking for jobs** as the dependent variable.*

By exploring attitudes towards the importance of the internet in communicational activities, which are shown in Tables 9 and 10, I found that the coefficients for living region, gender, age, and education level are still statistically significant, and in Model 3, the coefficient for income level is also statistically significant. Therefore, keeping other factors fixed, urban residents are 1.3 times more likely than rural residents to consider the internet as more important for maintaining family contact, and 1.3 times more likely to consider the internet as more important for contacting doctors during the pandemic. With regard to gender differences, controlling for the effects of all other variables, males are 37% less likely than females to consider the internet as more important for family contact, and 37% less likely to consider the internet as more important for contacting doctors during the pandemic. Holding other factors fixed, for every extra year, people's perceived probability of the internet being more helpful for family contact decreases by 1.5%, and the perceived probability of the internet being more helpful for contacting doctors also decreases by 1.5%. For every increase in education level, holding other factors unchanged, people's perceived probability of the internet being more important for family contact increases by 1.2 times and the probability of the internet being more helpful for contacting doctors increases by 1.1 times. Finally, keeping other factors constant, for every increase in income level (e.g., from under $30,000 per year to $30,000-$100,000 per year), people's perceived probability of the internet being more important for family contact decreases by 19.7%.

Table 9. Ordinal Logistic Regression Estimates of Communication Internet Activities

	Dependent variable:	
	Contact with friends and family	Connecting with doctors
	(3)	(4)
Urban	0.269*	0.295*
	(0.149)	(0.151)
Gender	−0.462***	−0.466***
	(0.121)	(0.123)
Age	−0.015***	−0.015***
	(0.004)	(0.004)
Education	0.209***	0.096***
	(0.036)	(0.036)
Employment	0.032	0.132
	(0.170)	(0.171)
Income	−0.219**	−0.030
	(0.092)	(0.093)
Intercepts:		
Not Important|Somewhat Important	−1.949***	−2.213***
	(0.364)	(0.371)
Somewhat Important|Very Important	−0.122	−0.444
	(0.358)	(0.364)
Observations	1,086	1,086

*Note: *p<0.1; **p<0.05; ***p<0.01. Data is from Pew Research Center.*

Table 10. Odds Ratio of Communication Internet Activities Models

Predictor	Odds Ratio	p value
Urban	1.309	7.147e-02
Gender	0.630	1.377e-04
Age	0.985	2.439e-04
Education	1.232	4.490e-09
Employment	1.032	8.510e-01
Income	0.803	1.666e-02

Predictor	Odds Ratio	p value
Urban	1.343	5.168e-02
Gender	0.628	1.564e-04
Age	0.985	3.247e-04
Education	1.101	7.166e-03
Employment	1.141	4.424e-01
Income	0.970	7.455e-01

*Note: Data is from Pew Research Center. The left table displays the odds ratio of each independent variables in the model which sets **contacting with friends and family** as the dependent variable, and the right one shows odds ratio in the model which sets **connecting with doctors** as the dependent variable.*

Based on the results regarding the importance placed on the internet, it can be concluded that disadvantaged groups, such as rural residents, older individuals, and those with lower levels of education, consider the internet to be less important in their information and communication activities during the pandemic compared to advantaged groups, such as urban residents, younger individuals, and those with higher levels of education. The gap in importance placed on the internet between urban and rural areas is significant, ranging from 30% to 60%, while the gap in importance based on age is relatively smaller, with only approximately a 5% difference when the age gap reaches 30 years.

With regards to the importance based on education, there is a significant gap of approximately 10% to 23% for those with different levels of education placing greater importance on the internet. Therefore, this study suggests that the focus of efforts to bridge the digital divide should be on reducing the importance gap of the internet between urban and rural residents. This could be achieved through encouraging telecommunication companies to build more base stations in rural areas, issuing policies and incentives to encourage the use of the internet by rural residents, and promoting the use of the internet to achieve more convenient living conditions. Additionally, based on the importance gap of the internet in education, more emphasis should be placed on the role of the internet in education, and individual difficulties in internet usage during study life should be addressed to help individuals effectively use the internet.

Furthermore, it was found that women are more likely to place greater importance on the internet than men, with a probability of approximately 25% to 45%, regardless of information or communication activities. This finding is consistent with previous research that indicates women have higher rates of internet usage for information and communication activities than men. This suggests a positive relationship between the importance placed on the internet and actual internet usage, which highlights the help of reducing the perceived

importance gap of the internet between urban and rural residents and education levels to effectively address the issue of the digital divide.

6. Conclusion

Using difference-in-differences regressions, I find that the COVID-19 pandemic has contributed to a reduction in the disparity between urban and rural populations in the use of the internet and email in the United States, with a decrease of approximately 6%. Moreover, I observe slight reductions in the gap between urban and rural areas in household internet subscription rates, mobile internet usage, and high-speed broadband service usage, although these reductions are not statistically significant. Finally, I find that the digital divide in social media use between urban and rural populations has improved by 5.2% after the pandemic. Analyzing several social media apps, I find that Facebook, Snapchat, and YouTube have experienced a reduction in the usage disparity between urban and rural populations of approximately 5%-8%.

Through ordinal logistic regressions, I find that during the pandemic, urban residents, women, younger individuals, and those with higher levels of education are more likely to value high-speed internet in informational internet activities. Similarly, these groups are also more likely to value the internet in communicative internet activities. Additionally, individuals with higher income level are more likely to consider high-speed internet more important for maintaining contact with families. My findings suggest that although the digital divide between urban and rural populations in the United States has partially diminished after the pandemic, advantaged groups still prioritize internet usage more than vulnerable groups during COVID-19 outbreak. This highlights the greater likelihood of advantaged groups using the internet during the pandemic.

The COVID-19 pandemic has made the internet an essential tool for people to stay connected with the outside world. During this special period, the government and some organizations and companies have made more efforts to ensure that the internet needs of the majority of people in society are met. As a result, there is a reduced trend in the urban-rural internet gap. The government and relevant departments should focus on which actions or policies during the pandemic have contributed to this reduction in the gap and use them as a guide to address the issue of the digital divide in the future. However, we must still be aware that the reduction in the urban-rural internet gap does not mean that the digital divide has been fully resolved. The gap still exists, and it is also reflected in the differences in the importance placed on the internet by individuals. Reducing the gap in the importance placed on the internet has a favorable impact on addressing the digital divide. Therefore, government and relevant departments need to ensure that the positive impact of the internet is present in the lives of disadvantaged groups, enabling them to enjoy the benefits of the internet and improve their lives.

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