Digital Citizenship and Digital Communities:

How Technology Matters for Individuals and Communities

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ABSTRACT

Over the past decade, the vision of smart cities filled with technological innovation and digitally engaged citizens has been pursued around the globe, but not all city residents have a chance to participate in or benefit from these innovations. Connectivity is unequally distributed across cities and neighborhoods, and these disparities have costs not only for individuals, but for communities, as COVID-19 so aptly demonstrated. There is a need to examine uses and outcomes for broadband across cities and neighborhoods as digital human capital in communities. Two studies summarized here show that like other human capital, technology use conveys economic benefits for communities. Broadband adoption over time is related to prosperity and growth in the 50 largest metros. Big data on the density of domain name websites shows that this measure of technology use is likewise a significant predictor of prosperity and median income, controlling for other factors. We conclude with a research agenda on digital human capital and community outcomes.

KEYWORDS

Digital Divide, Economic Development, Human Capital, Skills

1. INTRODUCTION

Over the past decade, the vision of smart cities filled with technological innovation and digitally engaged citizens has been pursued around the globe, but not all city residents have a chance to participate in or benefit from these innovations.

The coronavirus pandemic uncovered deep and persistent inequalities in technology access and use in the United States, more than a decade after the enactment of a National Broadband Plan (FCC 2010), and a quarter century after the first government report on the "digital divide" (National Telecommunications and Information Administration 1995). It exploded the myth that "everyone is online." As schools shut down and lessons went virtual, low-income students in urban areas were left behind, because of a lack of home internet access or adequate computers. School districts around the country scrambled to provide students with tablets and hot spots in parking lots, on school buses, or

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in homeless shelters (Stewart 2020; Romm 2020; Associated Press 2020). Vulnerable seniors who lacked internet access and skills to go online were at risk for social isolation and even food insecurity, as local store shelves were emptied (Conger and Griffith 2020). Doctor visits became virtual (Brody 2020) and those who were without internet access had limited health information and medical advice in the midst of a pandemic. There were also questions about the continued capacity of existing networks to handle the increased activity of telework, home schooling, telehealth, and emergency management, given that infrastructure reliability and speed vary considerably across neighborhoods and communities in the US, including in urban areas (Sallet 2020).

Digital inequality in the US is integrally linked to other economic, racial and ethnic disparities that have also emerged in full force during the pandemic, and going forward, it must be addressed in those terms. The US policy debate on digital inequality has often focused on rural infrastructure, particularly during the Trump administration, which has offered some modest funding for rural loans and grants (US Department of Agriculture 2020). While there is certainly limited or unreliable service available in some rural communities, especially on Tribal lands, affordability is the most important challenge in the US for both urban and rural communities (Tomer et al. 2017). In fact, there are three times as many urban than rural households without broadband of any kind, even mobile. Nationally, people of color are disproportionately represented among those with no broadband (Siefer and Callahan 2020).

Though 83% of the US population has some type of broadband subscription (counting both fixed broadband and mobile phones), connectivity is unequally distributed across cities and neighborhoods (American Community Survey 2017). There are zip codes in Memphis where only 26% of the population had any kind of broadband, including cellphones in 2017. Even in Silicon Valley's San Jose, where over 90% of residents have some type of broadband, there are zip codes where only 40% had fixed or mobile broadband, according to 2017 estimates. In Detroit only 67% of residents had a broadband subscription in 2017, and 19% of those relied on smartphones to go online. These less-connected, mobile-dependent internet users often turn to public libraries or Wi-Fi hot spots for homework, job search or other important needs (Fernandez et al. 2019). This hit many urban neighborhoods hard with the closure of public spaces and fast food restaurants in the pandemic. But the problem is not a short-term one that will simply be remedied as institutions open again.

These disparities have costs not only for individuals, but for communities, as COVID-19 so aptly demonstrated. Technology use affects equality of opportunity for individuals, for wages, education, health, and political participation. But it also has spillover benefits for communities and society. These benefits for communities have been more difficult to measure than the individual effects of technology use and disparities. One reason is the lack of adequate geographic data on broadband use: broadband adoption and activities online. With new data from the American Community Survey and the use of "big data" drawn from non-traditional sources, there are fresh opportunities to improve research and policy addressing urban technology use.

This article discusses the need to examine uses and outcomes for broadband across cities and neighborhoods. We discuss theories that bridge individual and community concerns, advocating for thinking about technology use as digital human capital in communities. We present evidence on how "place" matters for broadband and mobile use in low-income urban communities. We discuss data constraints and potential and summarize two current projects exploring community outcomes for digital human capital. Finally, we end with suggestions about opportunities for future research, and a need to examine urban disparities and their consequences to promote evidence-based policy for the future.

2. DIGITAL DIVIDES, DIGITAL CITIZENS, AND DIGITAL HUMAN CAPITAL

The concept of a "digital divide" appeared in a 1995 report issued by the US Bureau of the Census and the National Telecommunications and Information Administration, entitled "Falling Through the Net: A Survey of 'Have Nots' in Rural and Urban America." The report described disparities in computer and modem ownership, along with telephone penetration, tracing differences by race, ethnicity, income, education, age, and geography (region, rural, urban and central city). An important point made was that both central city and rural residents were disadvantaged in telecommunications access.

Since that report, there has been a consensus in the interdisciplinary scholarship on digital inequality that technology use requires skills and capacities as well as the internet connections and devices highlighted in early policy discussions. Necessary skills include not only technical competence using hardware and software, but online information literacy, or the ability to search for, evaluate and apply information from the internet (Mossberger, Tolbert and Stansbury 2003); skills for communicating, creating content; data literacy; safe use and more (Van Deursen and Van Dijk 2010; Van Deursen, Helsper and Eynon 2014; Schradie 2011; Van Deursen and Mossberger 2018).

Beyond access, differentiated uses or activities online are an important consideration in understanding how technology may narrow, reinforce or widen other social inequalities (Hargittai 2002). There is evidence across disciplines and policy areas that internet use is important for wages (DiMaggio and Bonikowksi 2008), including for less-educated workers (Mossberger, Tolbert and McNeal 2008), and for jobs that offer economic mobility without a college education (Horrigan 2018; Shearer and Shah 2018). Internet use matters for political participation and civic engagement (Mossberger, Tolbert and McNeal 2008; Boulianne 2009 and 2015), and access to health information and resources (Schartman-Cycyk et al. 2019).

Scholarship employing multiple disciplinary perspectives suggests how internet use matters for communities as well. As political scientists who study public policy, we have elsewhere characterized access to affordable broadband and skills for effective use as "digital citizenship" or the ability to participate in society online (Mossberger, Tolbert and McNeal 2008). Democratic participation and economic opportunity are especially linked to the notion of citizenship in the US. They represent both equality of opportunity for individuals and what economists and public policy scholars call spillover benefits, that accrue to society beyond gains for individuals. These positive externalities or spillover benefits create public goods, which may not be supplied sufficiently through the actions of individuals and markets. Both equal opportunity and spillover social benefits justify a public role in addressing digital inequality.

Sociologists and communications scholars have used the concept of digital capital, which Ragnedda (2018) defines as access, skills and outcomes. This supports other types of capital – economic, social, and cultural (Bourdieu 2008)– but also includes particular competencies and resources not subsumed under the other types of capital (Park 2017; Scheerder, Van Deursen and Van Dijk 2017; Ragnedda 2018). In a related vein, Hargittai (2002) has written about capital-enhancing activities on the internet that can improve an individual's life chances. These include use of the internet for jobs, finances, health, and political participation, in contrast with entertainment or recreational pursuits.

Digital capital and digital citizenship are individual-level concepts, but both point to uses of the internet that may serve the larger public interest. Capital adds value and it is transferable – it can be a resource that creates benefits for individuals, organizations or societies (Park 2017, chapter 2). In fact, Bach, Shaffer and Wolfson (2013) proposed a digital human capital framework that explicitly recognizes that digital capacities have spillover benefits, analogous to education.

Individual and community fortunes are increasingly driven by education and skills in the population in what economist Moretti has called the "human capital century" (Moretti 2012, 215). It is the positive externalities from education and skill that are "at the heart of modern economic growth theory" (Moretti 2012, 99 cf. Lucas 1988; Becker 1964). Thus, human capital is a collective resource, often measured in terms of educational attainment in a community. Like education, information technology is a public good with positive externalities because it provides users with access to information and represents valuable skills (Mossberger, Tolbert and Stansbury 2003; Mossberger, Tolbert and McNeal 2008).

Digital human capital in a community is the mechanism, then, for realizing the spillover benefits from digital citizenship or individual digital capital. This networked human capital enables information flows within and beyond the community, development and sharing of skills, and the employment of innovations. There may be spillovers and multipliers from these network interactions, just as cities benefit from density, proximity and interactions in physical space (Moretti 2012, 62; Glaeser 2011, 36). Network externalities increase with the size of the network, and the benefits should be highest in communities where digital human capital is more widespread and inclusive.

3. HOW PLACE MATTERS FOR TECHNOLOGY USE IN THE URBAN CONTEXT

Digital human capital is not evenly distributed across places, and the local context matters for its development. Social and economic inequality in the US is spatially-patterned, which has implications for both opportunities to use technology and for local outcomes.

Systematically comparing and mapping disparities in broadband adoption and use in the US has been difficult until recently, although new data from the American Community Survey (ACS) is improving knowledge of place-based variation across cities and neighborhoods.[1] The American Community Survey began collecting data on broadband subscriptions, including mobile, in 2013, initially available only for cities or counties with populations of 65,000 or more. Stark differences were apparent across major cities, despite the general availability of broadband. In Detroit, only 48% had fixed broadband at home in 2017, compared with 85% in Seattle. This is a nearly 40 percentage point difference across two major cities within the same country.

This city-level data, however, obscured even greater disparities within cities, especially for low-income and predominantly African American and Latino neighborhoods. Data from the ACS on broadband subscriptions became available for all census tracts only in December 2018 (5-year estimates for 2017). The Federal Communications Commission did release data on broadband subscriptions by census tract before this, but to protect the confidentiality of proprietary data from internet providers, reported subscriptions by quintiles (0-20%, 20-40%, 40-60%, etc.). For many years this was the best comparative data available to measure urban disparities, though communities with 40% of the population with broadband subscriptions were counted the same as those with 59%, making this a blunt instrument for comparing disparities or measuring change. Even with this imprecise and categorical data, the Brookings Institution concluded that nearly every metro included neighborhoods with subscription rates below 40% (Tomer et al. 2017).

Smartphone use has extended internet access to low-income households in recent years, especially in urban neighborhoods (Fernandez et al. 2019; Galperin, Bar and Kim 2017; Mossberger, Tolbert and Anderson 2017). With small screens and virtual keyboards, cell phones are inadequate, however, for doing homework or writing job resumes. The data caps that accompany many low-cost plans make minutes online a precious commodity and an unforeseen expense when they are exceeded. Still, research in Chicago showed that while mobile-dependent internet users engaged in fewer political and economic activities online overall, African-Americans and Latinos were more likely than other residents to participate in such activities using mobile access, especially those who lived in poor neighborhoods (Mossberger, Tolbert and Anderson 2017). This is consistent with qualitative research in low-income communities that reveals that residents are motivated to go online despite challenges (Fernandez et al. 2019; Dailey et al. 2010). The more limited form of access, however, has led some researchers to characterize mobile-dependent internet users as a digital underclass (Galperin, Bar and Kim 2017).

The recency of data from the American Community Survey has made it difficult to track outcomes in communities over time. Some research has used the large-sample Current Population Survey (US Bureau of the Census) to estimate broadband subscriptions for larger cities, counties and metros between 2000 and 2012 (Mossberger, Tolbert and Franko 2013; Tolbert and Mossberger 2015).[2] This provides a foundation for time series analysis and causal claims about the role of broadband in outcomes for health, education, or employment.

Table 1. Internet Use and Online Activities for Lowest-Ranked Chicago Community Areas, 2013 (Source: Mossberger, Tolbert and Anderson 2015, p. 21)

Broadband Adoption Lowest-Ranked Area (%)	Internet Use Percentage	Health Info Percentage	Job Search Percentage	Online Class Percentage
WEST GARFIELD (39%)	63	49	30	17
BURNSIDE (39%)	57	50	24	17
BRIGHTON PARK (40%)	61	49	25	17
GAGE PARK (42%)	64	51	28	16
SOUTH LAWNDALE (43%)	62	53	33	17
EAST SIDE (43%)	61	52	24	15
CITY AVERAGE (70%)	84	74	58	45
Broadband Adoption Lowest-Ranked Area (%)	**Transportation Info Percentage**	**E-government Info Percentage**	**Chicago Govt. Website Percentage**	**Politics Info Percentage**
WEST GARFIELD (39%)	45	36	41	35
BURNSIDE (39%)	36	40	40	38
BRIGHTON PARK (40%)	36	32	37	26
GAGE PARK (42%)	34	31	36	25
SOUTH LAWNDALE (43%)	34	33	36	27
EAST SIDE (43%)	35	35	36	30
CITY AVERAGE (70%)	66	61	58	60

Source: Mossberger, Tolbert and Anderson 2015, p. 21

The ACS and the FCC data do not include information on activities online, an important aspect of digital human capital. In some cases, researchers or cities have fielded local surveys to fill this gap. One study in Detroit surveyed select neighborhoods (Fernandez et al. 2019). Citywide surveys reporting neighborhood-level data have been conducted in Seattle (Pacific Research Group 2019) and Chicago (Mossberger, Tolbert and Anderson 2015) over multiple years, for example. The three city-wide Chicago surveys, covering a 5-year period, provided estimates on barriers and uses for digital human capital for each of Chicago's 77 community areas. The lowest-ranked neighborhoods, poor and predominantly communities of color, had far fewer residents who engaged in any of the capital-enhancing activities included in the survey. As Table 1 shows, this ranged from 22 percentage points below the citywide average for use of the City of Chicago website, to 38 percentage points below the citywide average for political information-seeking.

4. HOW PLACES AFFECT TECHNOLOGY USE

Segregation and concentrated poverty influence technology use independent of individual characteristics like poverty or education. Multilevel modeling in one national study that identified the zip code of respondents found that poverty of place significantly diminished the chances of home internet adoption for all races or ethnic groups. Neighborhood income in fact explained the differences in home internet adoption between African Americans and non-Hispanic whites; disparities were in poor neighborhoods rather than for African Americans overall. Living in a poor area made home internet adoption less likely for Latinos as well, although it did not entirely account for differences with non-Hispanics (Mossberger, Tolbert and Gilbert 2006). Research on Chicago's 77 community areas demonstrates that living in segregated neighborhoods also magnifies barriers to internet use (Mossberger, Tolbert, Bowen and Jimenez 2012).

As Kneebone and Holmes (2016) indicate, those who are poor and live in high-poverty areas experience a double burden. In addition to having limited incomes, they must contend with environments that often have fewer job opportunities and less upward mobility (Kneebone and Holmes 2016). Neighborhood disadvantage for internet use is consistent with research on "neighborhood effects" in other policy areas such as health, education, and employment (Jargowsky 1997; Massey and Denton 1993; Wilson 1987). Chetty and Hendren (2017) have demonstrated that the places where children grow up exercise a causal effect on intergenerational mobility and lifetime earnings.

For technology use as well, concentrated poverty constrains opportunities and choices, affecting skills, knowledge and support, and resources for technology use. Those who live in high-poverty neighborhoods have unequal access to jobs, including jobs with IT use, where they can learn more about technology (Kaplan and Mossberger 2012). Unequal educational opportunities deprive residents in poor communities of the educational competencies needed for information literacy (Orfield and Lee 2005). Goods and services sold in poor neighborhoods are often more expensive, credit is less available, and consumer information about some practices leading to unanticipated costs for broadband subscriptions may be less well-known (Caplovitz 1967; Federal Reserve and Brookings 2008; Dailey et al. 2010). An "ecology of support" (Rhinesmith 2016) in localized social networks and neighborhood institutions is important for broadband adoption and skills (Rhinesmith 2016; Gangadharan and Byrum 2012). Yet, according to one study by the Social Science Research Council, "Communities with a large percentage of non-adopters face multiple, overlapping challenges to broadband use, from skill and language barriers, to problems with providers, to overburdened community intermediaries and overstretched public Internet access points" (Dailey et al. 2010, 6).

Rising inequality across cities and regions has grown in the U.S. in recent years, in what has been described as "the great divergence" (Moretti 2012) and "winner-take-all-urbanism" (Florida 2017). Compared to the manufacturing economy, the information technology industry and other knowledge-intensive firms have concentrated investment in what Moretti (2012) refers to as brain hubs, or cities with high shares of college-educated workers. This skill-biased change has been growing since the 1980s, and accelerated during the last recession (Giannone 2017). One way in which communities have addressed this growing inequality is to compete fiercely to attract technology firms, with the heated contest for Amazon's second headquarters as just one example. If human capital is indeed the key to growth in 21st century, then encouraging technology use in the population – accumulating digital human capital – may well be a more inclusive path for economic growth and community development, that can help to narrow economic and other inequalities within and across cities. The next section examines evidence on outcomes for digital human capital, focusing on economic benefits for residents as well as businesses.

5. OUTCOMES FOR DIGITAL HUMAN CAPITAL IN COMMUNITIES

Investments in broadband within communities may be of two types - in the physical capital necessary to power fast networks, and in the digital human capital needed to exploit the networks. There is more evidence on the community outcomes for physical capital, for the deployment of broadband infrastructure than for broadband use in local populations. As discussed in the prior section, the lack of community-level data on broadband use – whether subscriptions or activities online – has made it difficult to study adoption and use in local populations. Still, the literature on broadband infrastructure is suggestive.

The research on deployment points to generally positive economic outcomes, though with some unequal benefits in communities. This has been true over time and across nations, though with some differences for the impacts being studied (Gillett et al. 2006; Kolko 2010; Jayakar and Park 2013;

Atasoy 2013; Mack 2014; see also Falck 2017, Bertschek et al. 2016 and Abrardi and Cambini 2019 for international overviews). Gillett et al. (2006) investigated deployment by zip codes across the US and concluded that the introduction of broadband infrastructure was associated with faster growth in jobs and establishments, especially in IT-intensive firms. Crandall, Lehr and Litan (2007) noted positive relationships with employment across a range of economic sectors, including manufacturing, health care, finance, insurance, real estate, and education (Crandall, Lehr and Litan 2007). Kolko's national study (2012) revealed a positive association between broadband deployment and economic growth, though no relationship with wages for local residents. Atasoy's (2013) county-level research focused on labor effects between 1999 and 2007 and found that the impact of infrastructure deployment was positive for employment of college-educated workers, negative for less-skilled workers, and slightly greater for rural areas. In terms of these differential effects, Falck (2017) summarized international evidence that slow adoption of broadband by the population and limited technology skills in fact diminish the impact of infrastructure investments.[3] Thus, digital human capital is needed to fulfill the potential of physical capital.

Outcomes for Broadband Adoption

What is the impact, then, of digital human capital for communities? Some recent research on US communities demonstrates the benefits of more widespread technology use in the population, across urban and rural areas. These findings are especially relevant for understanding the costs of urban disparities.

New research explores outcomes for broadband adoption, or broadband subscriptions, in communities over time (Mossberger, Tolbert and LaCombe forthcoming). Data on subscriptions indicates the percentage of the population that has regular access to broadband, rather than depending on public access or Wi-Fi. Subscriptions afford individuals more discretion and autonomy to explore, develop skills and use technology in a variety of ways (Hassani 2006). Using multilevel models, subnational estimates for broadband subscriptions[4] were created from the Current Population Survey. Together with data on broadband subscriptions from the American Community Survey, researchers had access to data from 2000-2017 for the largest counties and for the 50 largest metropolitan areas.[5] We report only the metropolitan study here.

Time series analysis was used to examine the effects of broadband adoption on the Metro Monitor growth and prosperity indices developed by the Brookings Institution (Shearer et al. 2018). Prosperity is defined as changes in wages, productivity and standard of living in a community, and growth is defined as changes in jobs, jobs at young firms, and Gross Metropolitan Product. Across several different time series models, including lagged models, broadband subscriptions are consistently significant predictors for prosperity. They are also related to growth in some models, and to full-time employment over time. Interactions with millennials in the population are significant. So are interactions with metro IT employment, though this decreases over time. Clearly broadband adoption in the population leads to more employment and greater prosperity – higher wages, productivity and standard of living – and in some cases to more growth.

Other models show positive economic results for counties as well with somewhat different measures. With time series analysis examining nearly two decades of data, there is a strong argument that broadband adoption, or digital human capital, is a cause of these outcomes.

Outcomes for Broadband Use: Digital Entrepreneurship

While broadband subscriptions facilitate technology use, they do not indicate much about the digital activities carried out in a community, especially capital-enhancing activities. Certain activities may be more directly linked to specific community outcomes – job search for employment outcomes, health information for public health, etc. But activities online have been impossible to measure across communities in the US, as the American Community Survey only tracks internet connections and devices.

Non-traditional sources of data can be used to provide new insights. GoDaddy, the world's largest registrar of domain names, shared data on its 20 million US websites with researchers to understand how these online "ventures" affect communities (Mossberger, Tolbert and LaCombe 2020). A venture is the term used by GoDaddy to describe discrete domain name websites that are actively being used. Ventures may be businesses, nonprofits, causes or ideas that owners put online. We asked how the density of domain name websites in a community (the number of ventures per 100 people in a county or a zip code), is related to local prosperity and economic opportunity.

Ventures provide a collective measure of effective broadband use and skill rather than only adoption. Content creation online is less prevalent than information use (Hargittai and Walejko 2008). Website creation and content management represent more demanding skills than common uses of the internet such as email, as they entail strategic use of technology (Van Deursen and Van Dijk 2010). Directly measuring the density of domain name websites for local communities avoids many methodological problems with survey data on skills. Individual-level data on digital skills is often self-reported and may be subject to bias (Hargittai 2005; Van Deursen and Van Dijk 2010). Aggregated to the community level, the density of domain websites is an additional measure of digital human capital, that provides information on more highly-skilled and more specific uses than subscription data alone.

Because websites are used by all kinds of organizations and individuals, more information is needed about the purposes of the websites. Using machine learning to categorize information from the home pages, data scientists at GoDaddy estimated that approximately 80% of the ventures were commercial. While this included businesses large and small, measuring the number of ventures per capita rather venture income emphasized the presence of small entrepreneurs. Comparisons with small business data from the US Census showed a moderate amount of overlap with ventures. [6] National maps also revealed some regional differences between small businesses and ventures, with a higher density of ventures in some parts of the country, compared with small business density. Clearly venture data captures something about the digital economy in communities not currently measured in government data.

The density of ventures provides a unique view of internet use for microbusinesses, start-ups and gig economy endeavors too small to be counted in government data. An online survey was administered by GoDaddy in August 2019 to a random sample of venture owners, yielding 2,006 completed responses. The survey confirmed the prior analysis using machine learning, as 75% of respondents said their ventures were commercial. Only 7% had more than 11 employees, and 31% were solo entrepreneurs. Most ventures were brick and mortar businesses as well, but 19% of the ventures were online only. One in five venture owners did not have full-time businesses or employment. The latter included part-time workers, students, retirees, stay-at-home parents, and people with disabilities. This new measure uncovered grassroots activity that contributes to entrepreneurship and digital human capital in the community.

To evaluate the impact of ventures on surrounding communities, data was analyzed for different geographies. This included zip codes, which are often used to represent neighborhood variation within cities. For the analysis below, the county-level results were reported, but models were tested at the zip code level as well. In most cases, the relationships were the same, whether using counties or zip codes as units of analysis.

Data scientists at the company de-identified and geocoded the data for the zip code of the venture owner and used machine learning to create 4 clusters based on levels of activity. These were based on the demand (traffic), connections (networking to other sites), and breadth of domain development (such as services attached to the site). In the analysis discussed below (Mossberger, Tolbert and LaCombe 2020), 2/3 of the clusters were in the lowest two categories of activity (active ventures), and about 1/3 were in the two highest-activity categories (highly-active ventures).

Using multivariate regression, the research examined whether ventures are related to community prosperity, recovery from the last recession, or change in median household income. Measuring

Figure 1. Density of Ventures (Domain Name Websites and their Redirects) per 100 people, by Zip Code (Source: Mossberger, Tolbert and LaCombe 2020, p. 7)

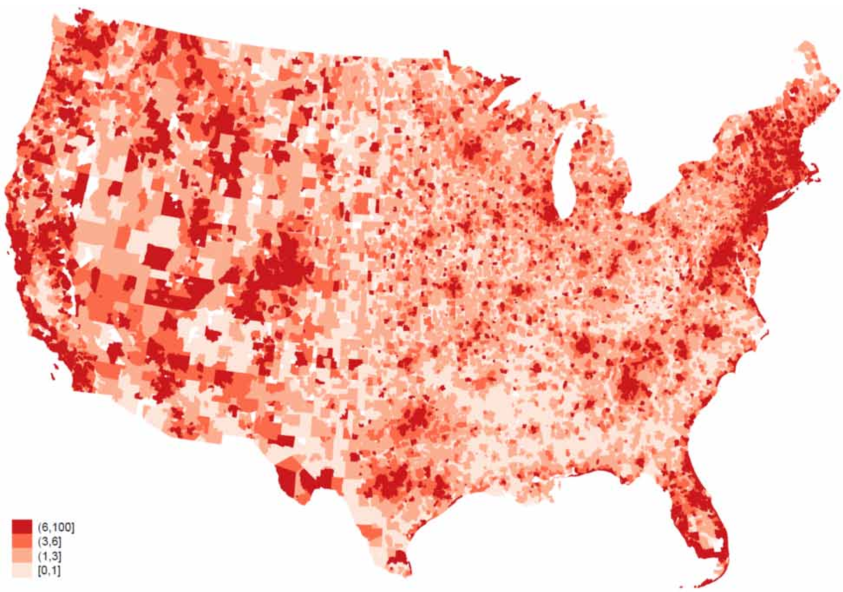
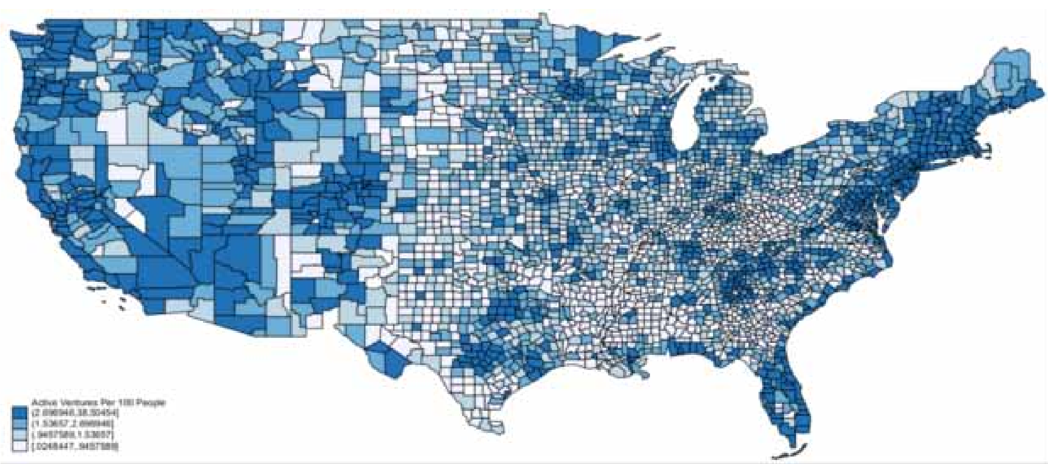


Figure 2. Density of Ventures (Domain Name Websites and their Redirects) per 100 people, by County (Source: Mossberger, Tolbert and LaCombe 2020, p. 6)



change, whether change in prosperity or median income, helps controls for endogeneity. Two-stage models were used to further distinguish the effects of ventures from small businesses, broadband subscriptions and affluence in the community.

The prosperity index used in this study was compiled by a think tank called the Economic Innovation Group (EIG). The index is available for counties and zip codes and includes educational attainment, housing vacancy, population in the workforce, poverty rate, household median income as a ratio of state median income, change in jobs, and change in businesses.[7]

Controlling for broadband subscriptions, demographic variables, and industries, the density of ventures was significantly and positively related to higher scores on the prosperity index. This was true for highly active ventures and for ventures overall, and for urban counties as well as all counties. While broadband subscriptions were significant as well, ventures mattered even more.

In two-stage models (stripping out the effects of broadband subscriptions, small businesses and median income in the first stage) the effect becomes even larger. This eliminates rival hypotheses that the results might actually be accounted for by broadband adoption, traditional measures of small business, or community affluence rather than broadband.

In other models, highly active ventures predicted median household income. For every highly active venture added to a county, median household income increased by $408 between 2016 and 2018. The density of ventures was also significantly related to a fuller recovery from the last recession.

This analysis included all counties and zip codes, urban and rural. While it did not address urban neighborhoods specifically, the zip code models used to confirm the reported county analysis demonstrated that similar results were observed even at this more granular level.

Further research on ventures in urban zip codes might provide some interesting findings. The project website[8] reports analysis examining the factors associated with higher venture density in metropolitan and micropolitan regions. This includes traditional measures of human capital in the information economy such as college-educated workers, IT employment, and digitally savvy millennials. Other factors included higher foreign-born populations and a higher proportion of broadband subscriptions in households with annual incomes of $20,000 or less. This was around the official poverty threshold for a household of 3 in 2019.[9] In communities where a greater share of low-income households have broadband subscriptions, they are able to create ventures for entrepreneurship and other purposes, adding to the digital human capital of the community.

6. CONCLUSION

In this moment when digital inequalities have become so apparent in the US and other societies, and social movements are calling attention to the structural causes and systematic effects of racism, there is an opportunity to set an agenda to increase equitable digital human capital in communities. There is a need to produce research to inform policy and planning from the local to the national level, to effectively target resources and to evaluate solutions. Research is needed for evidence on the patterns, causes and consequences of technology disparities across urban communities; to illuminate needs and enlighten policy debates.

In the urban context, research must address broadband adoption and use in neighborhoods and cities, as well as the possibilities for gigabit networks and smart city solutions. One of the challenges for defining and studying urban technology inequalities has been the lack of systematic or sufficiently precise data at the subnational level, across cities and within them. In the US, the American Community Survey (ACS) now provides a resource for describing current patterns of inequality in broadband subscriptions across neighborhoods. This data has shown stark differences in broadband adoption within counties or cities, including the concentration of mobile-only use in low-income communities (Galperin, Bar and Kim 2017). Over time, it can facilitate research on outcomes for adoption, but data for cities has only been available since 2014, and for census tracts since 2017.

Data on subscriptions has been estimated for larger principal cities, metros and counties, using the Current Population Survey prior to the American Community Survey (Tolbert and Mossberger 2015). This publicly available data has been used in research on economic outcomes (Mossberger, Tolbert and LaCombe forthcoming), but many other outcomes for this measure of digital human capital can and should be explored over time – for health, education, political participation, and more.

Still, more is needed to complete the picture of digital human capital in urban communities. Neighborhood-level data is needed, because of variation within cities due to concentrated poverty and segregation. Moreover, the ACS only tracks broadband connections and devices. Data is needed on how activities online and outcomes differ across and within cities. Local surveys can highlight differences across broad areas within the city (see Pacific Group 2019 for Seattle) or create data for neighborhoods through multilevel modeling and estimation (see Mossberger, Tolbert and Anderson 2015). In the UK, digital and social metrics have been combined from national data to estimate the likelihood of digital exclusion in different regions (The Tech Partnership 2017). Surveys that focus on selected neighborhoods can also yield an understanding of commonalities and differences within cities (Fernandez et al 2019).

Researchers may also consider using new forms of data beyond surveys to track activities online, given the many different types of data generated by internet use. Website data, search engine data, and social media are obvious candidates. Searches for health information may increase with broadband adoption, leading to better health outcomes over time. Partnerships with local institutions such as schools and hospitals could provide data for program evaluations or more general research. What effect does the use of telehealth or patient portals have on health disparities? What is the impact of greater connectivity among students for classroom practices and outcomes such as test scores or graduation rates? When there is more inclusive broadband, does use of the local government website increase, or are citizens more likely to be engaged with local governments through social media or other platforms? The availability of neighborhood-level data on broadband adoption can provide a starting point for these further steps. The ethnographic studies, case studies, focus groups and interviews that have been prevalent in urban digital research will continue to play an important role for understanding how digital human capital matters across neighborhoods (Rhinesmith 2016; Gangadharan and Byrum 2012; Dailey et al. 2010; Crowell forthcoming). They can help to tell the story behind these other types of evidence.

An urban research agenda on digital human capital can draw on multiple methods and disciplines, addressing diverse policy areas and outcomes. Spatial disparities in technology use have implications for information and democratic engagement in planning processes, empowering some cities and neighborhoods more than others. They affect the ability of local governments to realize the efficiencies and cost savings made possible through e-government or through smart city initiatives (Schartman-Cycyk et al. 2019; Horrigan 2019). They influence employment, workforce development, entrepreneurship and economic development in neighborhoods and cities. Beyond remote learning in the pandemic, neighborhoods and schools may suffer where students and households are unconnected or less-connected. Research and planning can contribute to choices and solutions for cities that are digitally inclusive as well as smart.

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ENDNOTES

1 See Galperin, Bar and Kim 2017 for an example of mapping for broadband subscriptions in Los Angeles.

2 The Iowa-ASU Broadband Data portal (NSF #1338471) makes this data publicly available at https://techdatasociety.asu.edu/broadband-data-portal/home. The initial datasets 2000-2014 are also available at Harvard Dataverse.

3 International comparisons employing country-level data on broadband adoption have also demonstrated stronger economic impacts for adoption than for deployment (Bertschek et al. 2016), including a study of 27 member countries of the European Union from 2005-2011 (Gruber et al. 2014).

4 Mobile subscriptions were included as broadband in years when that was tracked in the census surveys.

5 Counties were included in the analysis as well (see Mossberger, Tolbert and LaCombe forthcoming).

6 If small businesses are defined as having 100 employees or less, the correlation with ventures is 0.43. For small businesses defined as having 10 or fewer employees, the correlation with ventures is 0.53.

7 The index was originally created by the Economic Innovation Group (EIG) as the Distressed Communities Index, and communities were placed on a continuum of distress to prosperity. For the purposes of this study, to measure outcomes for prosperity, the index was reversed (1 minus the DCI score).

8 https://www.godaddy.com/ventureforward/local-city-data

9 https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html

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