**HANDHELD DEVICE OWNERSHIP: REDUCING THE DIGITAL DIVIDE?**

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**ABSTRACT**

In the United States, there is a persistent digital divide, or gulf between those who have and lack ready access to computers and the Internet. The potential for smartphones and mobile broadband to reduce the digital divide is quite promising, as groups with lower rates of access overall—including racial/ethnic minorities and low-income households—are more likely to own a handheld device only. This technology further has the potential to bolster access in underserved geographic areas including rural areas and poorer urban neighborhoods. However, those who access the Internet only through their phones have more tenuous access than those with more options. In this paper, I used data from the 2015 1-year American Community Survey (ACS) to look closely at current handheld device ownership. A key strength of the ACS is its large sample, enabling analysis of smaller population subgroups and sub-state geographies. First, I examined demographic, economic, and geographic characteristics related to handheld device ownership. In addition to looking at descriptive statistics on bivariate relationships, I conducted logistic regression to investigate the characteristics of two groups: 1) households that own a handheld device, and 2) households that own a handheld device only. Second, I assessed the geography of handheld ownership, looking at the Atlanta and Washington, DC metro areas and Public Use Microdata Areas (PUMAs) within the Atlanta and DC areas. PUMAs are built on Census tracts and counties, and allow comparisons between more rural and urban areas as well as within urban areas. I conclude by discussing the implications of handheld device ownership for reducing the digital divide, considering differences in the capabilities of handheld versus conventional devices.

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[1] This paper is released to inform interested parties of research and to encourage discussion. The views expressed on statistical issues are those of the author and not necessarily those of the U.S. Census Bureau.
[2] An earlier version of this paper was presented at the 2016 Annual Meeting of the Southern Demographic Association.

**INTRODUCTION**

In the United States, there is a persistent digital divide, or gulf between those who have and lack ready access to computers and the Internet. The Obama Administration implemented its Connecting America initiative to increase the share of Americans with high-speed Internet access, and President-elect Trump has pledged to invest in telecommunications infrastructure. High-speed Internet access is key for a variety of opportunities and outcomes.

There is potential to reduce the digital divide through greater use of smartphones and mobile broadband. Indeed, the share of Americans with smartphones has grown (Smith 2015). Groups with lower rates of Internet access overall—including racial/ethnic minorities and low-income households—are more likely to own a handheld device only (File and Ryan 2014). Mobile technology further has promise for bolstering access in underserved geographic areas including rural areas and poorer urban neighborhoods.

In the current study, I used data from the 2015 American Community Survey (ACS) to look closely at current handheld device ownership. A key strength of the ACS is its large sample, enabling analysis of smaller population subgroups and sub-state geographies. First, I reviewed descriptive statistics and conducted logistic regression to investigate the characteristics of two groups: 1) households that own a handheld device, and 2) households that own a handheld device only (I sometimes refer to this group as "smartphone dependent."). Second, I assessed the geography of handheld ownership, looking at the Atlanta and Washington, DC metro areas and Public Use Microdata Areas (PUMAs) within the Atlanta and DC areas. Results contribute to our understanding of whether mobile technology promotes Internet access for groups with reduced connectivity, and this information in turn can inform strategies for addressing the digital divide.

**BACKGROUND**

**Previous Research**

High-speed Internet access promotes a number of opportunities and positive developments. The Internet is used for a variety of activities including accessing health information, online banking, choosing a place to live, finding information on and applying for jobs, looking up government services, and taking classes. A majority of Americans believes that those without home broadband are at a major disadvantage when it comes to looking for job opportunities, accessing government services, learning

new things, obtaining health information, or getting news and information (Horrigan and Duggan 2015). More and more, courts and regulators view broadband as an essential utility rather than a luxury (Kang 2016).

Several groups experience lower levels of Internet access, including older Americans, racial/ethnic minorities, those with limited English skills, lower-income households, and those residing outside of metropolitan areas (File and Ryan 2014). Handheld access is key for some of these groups. Those with relatively low income and educational attainment, as well as non-whites, are especially likely to be smartphone-dependent (Smith 2015).

However, handheld devices are not always an adequate substitute for Internet access through more conventional devices. Those who access the Internet only through their phones have more tenuous access than those with more options. Smith (2015) found that nearly half of smartphone-dependent Americans have had to cancel their cell phone service for a span of time because the associated cost was a financial burden. In addition, compared with smartphone owners with more than one route to Internet access, a greater share of the smartphone-dependent report reaching the maximum amount of data allowed as part of their cell phone plan. Both issues are more common for nonwhites and those with lower incomes. Indeed, those who depend on mobile devices for Internet access at home often rely on a "workaround ecosystem" combining use of their smartphones along with other supports such as computers and Internet available at public libraries (Anderson and Horrigan 2016).

**Current Study**

In the current study, I look more closely at handheld device ownership, considering both overall ownership and dependence on such devices for Internet access. Specifically, I address two research questions:

- **How do demographic, economic, and geographic characteristics relate to handheld device ownership?**
- **What does handheld device ownership look like within the Atlanta and Washington, DC metro areas?**

When answering the first question, I consider a variety of demographic, economic, and geographic factors. To address the second, I look at the Atlanta and Washington, DC Metropolitan Statistical Areas (MSAs) overall and PUMAs within these MSAs. Although past studies have often focused on differences between urban and rural areas, I also consider variation within urban areas. The aim is to learn more about handheld adoption and dependence in order to inform strategies addressing the digital divide.

**METHODOLOGY**

**Data**

I used data from the 2015 1-year ACS. [3] The ACS is sponsored by the Census Bureau as part of the Decennial Census Program, with data collection also conducted by the Census Bureau. About 3.5 million households are selected each year via multistage probability sampling. The survey is administered through multiple modes including Internet, mailout/mailback, Computer Assisted Telephone Interview (CATI), and Computer Assisted Personal Interview (CAPI). Because questions about computer and handheld ownership are asked of households, I conducted all analysis at the household level. For characteristics originally asked of individuals, I used householders' characteristics to represent a household. [4]

**Measures**

*Dependent variables*. I used two variables to describe handheld device ownership. The first captures overall handheld device ownership, and uses a survey question asking about ownership of a handheld computer, smart mobile phone, or other handheld wireless computer. [5] The second denotes handheld-

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[3] For an overview of sample design, estimation methodology, and accuracy of the 2015 1-year ACS data, see https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/ACS_Accuracy_of_Data_2015.pdf.

[4] In the ACS, one person in each household is designated as the householder. In most cases, this is the person or one of the people in whose name the home is owned, being bought, or rented and who is listed on line one of the survey questionnaire. If there is no such person in the household, any adult household member 15 years old and over could be designated as the householder.

[5] Although ACS respondents report smartphone ownership through this item, they may also use the item to report other handheld devices such as tablets. Throughout the paper, I use the term "handheld" rather than "smartphone" when describing ACS data and results.

device-only ownership, or households that own a handheld device and do not own a desktop, laptop, or other type of computer.

*Independent variables.* I looked at a number of demographic, economic, and geographic characteristics to explore their relationship with handheld device ownership. Demographic factors of interest include householder age, householder race/ethnicity, household presence of children, householder English-speaking ability, householder educational attainment, and householder disability status. Economic variables analyzed include household poverty status and householder employment status. Geographic factors examined consist of region, metropolitan status, and urban/rural status.

*Geographic detail.* In addition to looking at overarching geographic characteristics, I inspected handheld device ownership for the Atlanta-Sandy Springs-Roswell, GA and Washington-Arlington-Alexandria, DC-VA-MD-WV MSAs. MSAs are defined by the Office of Management and Budget (OMB), and are composed of counties. Each encompasses a core urban area of 50,000 or more population and adjacent counties with a high degree of social and economic integration with the core.

I further examined PUMAs partially or entirely within the Atlanta and Washington, DC MSAs. This allowed comparisons between more rural and urban areas as well as within urban areas. PUMAs are non-overlapping areas that are built on Census tracts and counties, and divide states into geographic units of at least 100,000 people each. The current PUMA boundaries were drawn following the 2010 Census by State Data Centers, in cooperation with regional, state, local, and tribal organizations. [6]

**Method of Analysis**

In the first stage of analysis, I examined characteristics related to handheld device ownership. I first looked at descriptive statistics on bivariate relationships between each independent variable and the dependent variables. I then used logistic regression predicting the likelihood of 1) owning a handheld device and 2) owning a handheld device only. Logistic regression is an appropriate method for analyzing the dichotomous dependent variables. For each outcome, I ran a single model containing all independent variables.

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[6] For more information on PUMA definitions and delineations, see http://www.census.gov/geo/reference/puma.html.

For the second phase of analysis, I looked further at the geography of handheld device ownership. First, I calculated handheld ownership and handheld-only ownership for the U.S. overall and for the Atlanta and Washington, DC MSAs. Next, I assessed handheld device ownership for PUMAs within the Atlanta and Washington, DC metro areas. In addition to noting the range of values among PUMAs and comparing PUMAs with the national average, I mapped handheld ownership and handheld-only ownership by PUMA. This allowed a look at both differences within the more urban portion of the MSAs as well as between the urban core and more suburban/rural parts.

**RESULTS**

**Characteristics Related to Handheld Device Ownership**

*Descriptive statistics.* Table 1 displays the percentage of households 1) owning a handheld device and 2) owning a handheld device only, by a variety of demographic, economic, and geographic characteristics. When looking at individual characteristics, I assess the traits of the householder/reference person, as this person plays an important, if not exclusive, role in making purchasing decisions. Overall, we see that about 75 percent of American households own a handheld device and about 8 percent have a handheld device only.

Starting with householder age, handheld ownership is very common for households with a householder aged 44 or younger, at about 89-90 percent. [7] It is less common for homes with a householder aged 45 to 64 (78 percent), and least common for those with a householder aged 65 and over (47 percent). The share of households owning a handheld device only is greatest for homes with the youngest reference persons, characterizing 16 percent of homes headed by a person aged 15 to 24. This percentage decreases for each subsequent age group, with only 5 percent of homes headed by a person aged 65 and over relying on handheld devices for Internet access. Together, these results suggest that young people are both more likely to adopt handhelds and to rely on them.

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[7] Though differences in handheld ownership among the 15-to-24, 25-to-34, and 35-to-44 age groups are all less than 1.5 percentage points, they are statistically different.

**Table 1. Characteristics of Households Owning Handheld Device and Handheld Device Only**

| | Owns Handheld Device | | Owns Handheld Device Only | |
|---|---|---|---|---|
| | Percent | *Margin of Error* | Percent | *Margin of Error* |
| **Total** | 74.8 | 0.07 | 7.9 | 0.05 |
| **Householder age** | | | | |
| 15 to 24 years | 89.8 | 0.26 | 15.9 | 0.34 |
| 25 to 34 years | 90.4 | 0.14 | 11.9 | 0.16 |
| 35 to 44 years | 89.0 | 0.11 | 9.0 | 0.12 |
| 45 to 64 years | 78.5 | 0.09 | 6.9 | 0.06 |
| 65 years and over | 47.1 | 0.14 | 4.8 | 0.05 |
| **Householder race and Hispanic origin** | | | | |
| White alone, non-Hispanic | 74.6 | 0.08 | 5.8 | 0.05 |
| Black alone, non-Hispanic | 70.3 | 0.20 | 13.9 | 0.17 |
| Asian alone, non-Hispanic | 87.2 | 0.23 | 3.5 | 0.13 |
| Other race, non-Hispanic | 77.1 | 0.36 | 9.7 | 0.27 |
| Hispanic | 75.8 | 0.21 | 14.5 | 0.16 |
| **Household poverty level** | | | | |
| Below poverty level | 60.2 | 0.18 | 15.6 | 0.16 |
| Above poverty level | 77.2 | 0.07 | 6.6 | 0.05 |
| **Household presence of children** | | | | |
| Without children under 18 years | 68.2 | 0.09 | 7.2 | 0.05 |
| With child(ren) under 18 years | 89.3 | 0.10 | 9.3 | 0.09 |
| **Householder English-speaking ability** | | | | |
| Not at all | 48.7 | 0.74 | 18.5 | 0.62 |
| Not well | 66.1 | 0.49 | 16.4 | 0.35 |
| Well | 77.1 | 0.30 | 10.6 | 0.26 |
| Very well | 83.4 | 0.19 | 8.2 | 0.12 |
| English only | 74.3 | 0.07 | 7.2 | 0.05 |
| **Householder educational attainment** | | | | |
| Less than high school | 50.9 | 0.21 | 15.8 | 0.19 |
| High school graduate | 62.8 | 0.13 | 11.8 | 0.12 |
| Some college or associate's degree | 79.2 | 0.11 | 7.6 | 0.07 |
| Bachelor's degree or more | 87.6 | 0.08 | 2.5 | 0.05 |
| **Householder employment status** | | | | |
| Employed | 86.1 | 0.07 | 7.9 | 0.07 |
| Unemployed | 76.5 | 0.41 | 14.7 | 0.35 |
| Not in labor force[1] | 53.6 | 0.11 | 7.2 | 0.07 |
| **Householder disability status** | | | | |
| No disability | 79.7 | 0.07 | 7.7 | 0.06 |
| With a disability | 51.4 | 0.15 | 8.6 | 0.10 |

See footnotes at end of table.

**Table 1. Characteristics of Households Owning Handheld Device and Handheld Device Only--Con.**

| | Owns Handheld Device | | Owns Handheld Device Only | |
|---|---|---|---|---|
| | Percent | Margin of Error | Percent | Margin of Error |
| **Region** | | | | |
| Northeast | 73.6 | 0.12 | 6.1 | 0.10 |
| Midwest | 73.1 | 0.12 | 7.9 | 0.09 |
| South | 74.1 | 0.12 | 9.2 | 0.08 |
| West | 78.7 | 0.12 | 7.0 | 0.09 |
| **Metropolitan status** | | | | |
| Metropolitan area | 76.7 | 0.06 | 7.6 | 0.06 |
| Micropolitan area | 66.8 | 0.24 | 9.1 | 0.14 |
| Outside metropolitan/micropolitan area | 61.0 | 0.27 | 9.6 | 0.17 |
| **Urban/rural status** | | | | |
| Urban area | 76.5 | 0.07 | 7.8 | 0.06 |
| Rural area | 67.8 | 0.16 | 8.1 | 0.08 |

[1] Includes those aged 15, who do not have information on employment status.
Source: U.S. Census Bureau, American Community Survey, 2015.
For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/ACS_Accuracy_of_Data_2015.pdf* .

Regarding householder race/ethnicity, Black-headed households are the least likely to possess a handheld device, at 70 percent, followed by White-headed households, at 75 percent. Ownership is most common for homes with an Asian householder (87 percent). Dependence on a handheld device is least common among Asian-headed households (4 percent), followed by White-headed homes (6 percent). Homes with a Black or Hispanic reference person have high rates of handheld-dependence, at 14-15 percent.[8] Thus, Blacks are disadvantaged, being both less likely to own a handheld and more likely to be dependent upon them for computing.

Households with income below the poverty level fare worse than those above poverty in terms of both overall handheld ownership and reliance on handheld devices. At 60 versus 77 percent, impoverished households are less likely than those above poverty to possess a handheld device. In contrast, a greater share of below-poverty households (16 percent) than their higher-income counterparts (7 percent) only own a handheld device.

Whether or not children are present relates to the types of devices a household owns. The share of households with a handheld device is higher when one or more children under 18 years are present,

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[8] The estimates for Black- and Hispanic-headed households differ statistically.

at 89 percent, than when no children are in the home, at 68 percent. Households with children are also more likely to have a handheld computer as their only Internet-capable device, at 9 versus 7 percent.

Looking next at householder English ability, homes where the householder speaks English not at all (49 percent) or not well (66 percent) fare more poorly than those where the householder speaks English only (74 percent) in terms of handheld ownership. In contrast, compared with households where the reference person speaks English only, handheld use is higher among households where the reference person speaks English well or very well, at 77 and 83 percent, respectively. The relationship between householder English ability and handheld-only ownership is negative. Handheld dependence is lowest for homes where the householder speaks only English, at 7 percent, and highest for those where the householder speaks it not at all, at about 19 percent. These results suggest that those with low English proficiency fare worse in terms of the digital divide.

Handheld ownership increases and handheld-dependence decreases with each increase in householder education. To illustrate, households where the reference person has at least a Bachelor's degree have the highest level of handheld ownership, at 88 percent and the lowest level of handheld-only ownership, at 2 percent. Thus, those with more education, as a group, have a number of options for accessing the Internet.

Differences by householder employment status are also apparent. Compared to households with an employed householder (86 percent), those with an unemployed householder (76 percent) or where the householder is not in the labor force (54 percent) less often own a handheld device. Although the difference in having a handheld only is small for homes with an employed householder versus a householder out of the labor force, at 8 versus 7 percent, it is more common for those with an unemployed householder, at 15 percent. Taken together, this suggests that the unemployed are more disadvantaged, being both less likely to own such devices and more likely to depend on them.

Looking at disability status, we see that people with disabilities have fewer options for Internet access. Compared to households where the reference person has no disability, those where the reference person has a disability are less likely to have a handheld computer, at 51 versus 80 percent. Handheld dependence is somewhat more common for homes with a disabled householder, at 9 percent, than for homes with a nondisabled householder, at 8 percent.

Geographic characteristics are also important for understanding handheld ownership and dependence. The West stands out as the region with the largest share of handheld-owning households,

at 79 percent. This value ranges from 73 to 74 percent for other regions in the U.S.[9] Dependence upon these devices is lowest for households in the Northeast (6 percent), followed by the West (7 percent), Midwest (8 percent), and South (9 percent).

Regarding metropolitan status, households within metropolitan areas are most advantaged in terms of Internet-capable devices, whereas those outside a metropolitan or micropolitan area are least advantaged.[10] Seventy-seven percent of homes in metropolitan areas own a handheld device, compared with 67 percent of those in micropolitan areas and only 61 percent of those outside a metropolitan or micropolitan area. The pattern for handheld-only ownership is reversed, with the highest level for nonmetropolitan/micropolitan households (10 percent), followed by micropolitan (9 percent) and metropolitan (8 percent) households.

Lastly, rural households are less likely to own handheld devices than their urban counterparts, at 68 versus 76 percent. The share of homes depending on handhelds for Internet access is about 8 percent in both rural and urban areas, although the value for rural homes is statistically higher.

*Logistic regression.* Table 2 presents results from the logistic regressions testing the likelihood of households 1) owning a handheld device and 2) owning a handheld device only. These findings provide information on whether and how various demographic, economic, and geographic factors relate to having a handheld computer.

Looking first at the effect of householder age, compared with households with a reference person aged 35 to 44, those with a younger householder are more likely to own a handheld device, and those with an older householder are less likely to do so. These differences are greatest when looking at the youngest and oldest age groups. Homes with a householder aged 25 to 34 are 1.2 times as likely as those with a householder aged 35 to 44 to have such a device, and the odds are still higher when a householder is aged 15 to 24 (1.9). At the other end of the spectrum, households with a reference person aged 45 to 64 are 67 percent as likely and those with a reference person aged 65 and over are only 24 percent as likely to possess a handheld device as when the reference person is aged 35 to 44.

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[9] Although differences in handheld ownership among the Northeast, Midwest, and South are all no more than a percentage point, they are statistically significant.
[10] Although both metropolitan and micropolitan areas capture some degree of urbanization, metropolitan areas have a population of at least 50,000 and micropolitan areas have a population of at least 10,000 but less than 50,000.

**Table 2. Logistic Regression Predicting Households' Likelihood of Owning Handheld Device and Handheld Device Only**

| | Owns Handheld Device | | | Owns Handheld Device Only | | |
|---|---|---|---|---|---|---|
| | Estimate | Standard Error | Odds Ratio | Estimate | Standard Error | Odds Ratio |
| **Householder age** *(reference category is 35 to 44 years)* | | | | | | |
| 15 to 24 years | 0.6167 *** | 0.02 | 1.85 | 0.4109 *** | 0.02 | 1.51 |
| 25 to 34 years | 0.1933 *** | 0.01 | 1.21 | 0.3588 *** | 0.01 | 1.43 |
| 45 to 64 years | -0.4083 *** | 0.01 | 0.67 | -0.3629 *** | 0.01 | 0.70 |
| 65 years and over | -1.4120 *** | 0.01 | 0.24 | -0.7858 *** | 0.01 | 0.46 |
| **Householder race and Hispanic origin** *(reference category is White alone, non-Hispanic)* | | | | | | |
| Black alone, non-Hispanic | -0.3281 *** | 0.01 | 0.72 | 0.6727 *** | 0.01 | 1.96 |
| Asian alone, non-Hispanic | 0.4603 *** | 0.02 | 1.59 | -0.3242 *** | 0.03 | 0.72 |
| Other race, non-Hispanic | -0.1095 *** | 0.01 | 0.90 | 0.3572 *** | 0.02 | 1.43 |
| Hispanic | -0.0656 *** | 0.01 | 0.94 | 0.5535 *** | 0.01 | 1.74 |
| **Household below poverty level** *(reference category is above poverty level)* | -0.7022 *** | 0.01 | 0.50 | 0.4060 *** | 0.01 | 1.50 |
| **Household with child(ren) under 18 years** *(reference category is without children under 18 years)* | 0.8587 *** | 0.01 | 2.36 | -0.1868 *** | 0.01 | 0.83 |
| **Householder English-speaking ability** *(reference category is English only)* | | | | | | |
| Not at all | -0.7889 *** | 0.02 | 0.45 | 0.2040 *** | 0.03 | 1.23 |
| Not well | -0.3530 *** | 0.02 | 0.70 | 0.2336 *** | 0.02 | 1.26 |
| Well | -0.1370 *** | 0.01 | 0.87 | 0.0227 | 0.02 | 1.02 |
| Very well | -0.0206 | 0.01 | 0.98 | -0.0814 *** | 0.01 | 0.92 |
| **Householder educational attainment** *(reference category is high school graduate)* | | | | | | |
| Less than high school | -0.3429 *** | 0.01 | 0.71 | 0.1579 *** | 0.01 | 1.17 |
| Some college or associate's degree | 0.6302 *** | 0.01 | 1.88 | -0.5440 *** | 0.01 | 0.58 |
| Bachelor's degree or more | 1.1541 *** | 0.01 | 3.17 | -1.5643 *** | 0.01 | 0.21 |
| **Householder employment status** *(reference category is employed)* | | | | | | |
| Unemployed | -0.2605 *** | 0.02 | 0.77 | 0.1974 *** | 0.02 | 1.22 |
| Not in labor force[1] | -0.5440 *** | 0.01 | 0.58 | -0.1372 *** | 0.01 | 0.87 |
| **Householder with a disability** *(reference category is no disability)* | -0.3539 *** | 0.01 | 0.70 | 0.1437 *** | 0.01 | 1.16 |

See footnotes at end of table.

**Table 2. Logistic Regression Predicting Households' Likelihood of Owning Handheld Device and Handheld Device Only--Con.**

| | Owns Handheld Device | | | Owns Handheld Device Only | | |
|---|---|---|---|---|---|---|
| | Estimate | Standard Error | Odds Ratio | Estimate | Standard Error | Odds Ratio |
| **Region** *(reference category is Northeast)* | | | | | | |
| Midwest | 0.0107 | 0.01 | 1.01 | 0.2354 *** | 0.01 | 1.27 |
| South | 0.1290 *** | 0.01 | 1.14 | 0.2635 *** | 0.01 | 1.30 |
| West | 0.2191 *** | 0.01 | 1.25 | 0.0717 *** | 0.01 | 1.07 |
| **Metropolitan status** *(reference category is outside metropolitan/micropolitan area)* | | | | | | |
| Metropolitan area | 0.4226 *** | 0.01 | 1.53 | -0.1248 *** | 0.02 | 0.88 |
| Micropolitan area | 0.1221 *** | 0.01 | 1.13 | -0.0108 | 0.02 | 0.99 |
| **Urban area** *(reference category is rural area)* | 0.1156 *** | 0.01 | 1.12 | -0.0849 *** | 0.01 | 0.92 |
| **Intercept** | 0.9418 *** | 0.01 | | -1.9916 *** | 0.02 | |
| **N** | 2,094,267 | | | 2,094,267 | | |

[1] Includes those aged 15, who do not have information on employment status.

Significance is noted as follows: *(p<0.05); **(p<0.01); ***(p<0.001).

Source: U.S. Census Bureau, American Community Survey, 2015.

For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/ACS_Accuracy_of_Data_2015.pdf* .

Householder age is also related to owning a handheld device only, with a similar pattern as general handheld ownership. Thus, as was observed for descriptive results, even when controlling for other factors, young people not only are more likely to adopt this newer technology, but also are more inclined to depend on handhelds for their computing needs.

Turning to race/ethnicity, compared with households with a White householder, those where the householder is Black, Hispanic, or of some other race (including multiple race) are less likely to own a handheld computer. This difference is greatest for homes with a black householder, which are 28 percent less likely than homes with a White householder to have a handheld device. In contrast, Asian-headed households are 59 percent more likely than White-headed households to possess a handheld.

A somewhat different picture emerges when reviewing the relationship between race/ethnicity and owning a handheld device only. Although households with an Asian householder are 72 percent as likely as those with a White householder to own a handheld only, all other minority groups are more likely than Whites to depend upon these devices for Internet access. Compared with White-headed households, those headed by a person of some other race are 1.4 times as likely to be handheld-dependent. The odds are still higher for Hispanic-headed (1.7) and Black-headed (2.0) homes. Thus, the digital divide is evident for Blacks, Hispanics, and those of some other race, as they are both less likely to own a handheld device overall and more likely to be reliant on them. These differences are particularly stark for Blacks, confirming descriptive results.

Confirming descriptive results, household poverty status is independently related to handheld device ownership. Compared with households above the poverty level, those below poverty are half as likely to have a handheld device and 50 percent more likely to have a handheld only. Thus, the digital divide is especially sharp for impoverished households.

As was seen previously, homes with children are more likely than those without children under 18 years to possess a handheld device. Indeed, the odds of handheld ownership are 2.4 times as high for households with children. In contrast to what was observed for the descriptive results, when controlling for other factors, households with children are 17 percent less likely than their counterparts without children to own a handheld only. That is, homes with children have greater computing capabilities, generally having access to handheld as well as other types of computers.

English proficiency is positively associated with having a handheld computer and negatively associated with having only a handheld. Note, however, that there is no difference in overall handheld

ownership between homes where the householder speaks only English and those where the householder speaks English very well. Nor does handheld-only ownership differ between homes where the reference person speaks only English and those where the reference person speaks English well. [11] To illustrate the general pattern, householders with the lowest level of English proficiency—that is, who do not speak English at all—are only about half as likely as those who speak English only to own a handheld device, and 1.2 times as likely to own a handheld only. Thus, consistent with descriptive results, those with low English proficiency have more barriers to Internet access.

Educational attainment is another factor related to handheld device ownership. As noted above, householder education has a positive relationship with handheld device ownership and a negative relationship with handheld-only ownership. For example, compared with householders with a high school degree, those with at least a bachelor's degree are 3.2 times as likely to have a handheld device and only 21 percent as likely to depend upon their handheld device.

Turning to employment status, consistent with descriptive results, households with an unemployed reference person fare badly in terms of the digital divide. These households are 23 percent less likely than those with an employed reference person to have a handheld computer, but 22 percent more likely to have a handheld only. Although householders who are out of the labor force are less likely than employed householders to own a handheld, they are also less likely to rely upon such devices for Internet access.

Disability status is also relevant for handheld device ownership, as homes headed by a person with a disability are 30 percent less likely than those headed by a person with no disability to have a handheld device. Householders with a disability are 16 percent more likely to only own a handheld than those with no disability. In keeping with the descriptive analysis, this suggests that the disabled are another group subject to the digital divide.

Geographic factors likewise relate to handheld possession, with variation by region. Compared with households in the Northeast, handheld ownership is more common in the South (odds=1.1) and West (odds=1.2). There is no difference in handheld ownership in the Midwest versus the Northeast.

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[11] In addition, handheld-only ownership does not differ between householders who do not speak English at all and those who reported their English proficiency as not well.

Handheld-only ownership is also more likely for the West (odds=1.1), Midwest (odds=1.3), and South (odds=1.3) versus the Northeast.

Looking at metropolitan status, households in micropolitan areas are 1.1 times as likely as those outside a metropolitan or micropolitan area to own a handheld device. The odds are still higher for those residing in a metropolitan area (1.5). Although micropolitan homes do not differ from those outside a metropolitan or micropolitan area in terms of handheld-only ownership, metropolitan homes are 12 percent less likely to own a handheld device only. Thus, as observed in the previous section, residents of metropolitan areas are most likely to access the Internet using more than one device.

Finally, rural households are more impacted by the digital divide. Consistent with descriptive results, households in urban areas are 12 percent more likely than those in rural areas to have a handheld device. Urban households are also 8 percent less likely to own a handheld device only.

**Geography of Handheld Device Ownership**

*Tables.* Table 3 displays the percentage of households owning a handheld device and owning a handheld device only for the nation overall as well as for the Atlanta and Washington, DC MSAs. Once more, for the U.S. as a whole, 75 percent of households possess a handheld device and 8 percent own a handheld only. Handheld ownership is more common in both the Atlanta (83 percent) and Washington, DC (85 percent) metro areas. Although handheld-only ownership in Atlanta does not differ from the national average, it is lower among households in the Washington, DC metro area, at 5 percent.

**Table 3. Percentage of Households Owning Handheld Device and Handheld Device Only in Atlanta and Washington, DC Metropolitan Statistical Areas**

|  | Owns Handheld Device | | Owns Handheld Device Only | |
| --- | --- | --- | --- | --- |
|  | Percent | *Margin of Error* | Percent | *Margin of Error* |
| U.S. total | 74.8 | 0.07 | 7.9 | 0.05 |
| Atlanta-Sandy Springs-Roswell, GA | 83.0 | 0.43 | 7.6 | 0.36 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 84.8 | 0.41 | 5.2 | 0.22 |

Source: U.S. Census Bureau, American Community Survey, 2015.
For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/ACS_Accuracy_of_Data_2015.pdf* .

Finer geographic variation can be seen in Table 4, which depicts handheld device and handheld-only ownership among PUMAs within the Atlanta and Washington, DC MSAs. There are a total of 45 PUMAs in the Atlanta area, with an average population of about 139,000. The DC area has 47 PUMAs with an average of about 142,000 people in each. Looking first at overall ownership, there is considerable variation within each MSA, as values for individual PUMAs range from 60 to 96 percent within Atlanta and from 66 to 95 percent within the Washington, DC metro area. Further, although handheld ownership for the Atlanta MSA overall is more common than the national average of 75 percent, this is true for only 73 percent of Atlanta PUMAs. Handheld ownership is comparable to the national value for 13 percent of Atlanta PUMAs, and 13 percent have below-average levels. Handheld ownership is more common within the DC metro area, as a greater share of PUMAs (81 percent) has above-average levels of handheld device ownership. Handheld ownership is similar to the national level for 13 percent of DC-area PUMAs and below average for only 6 percent.

**Table 4. Handheld Device and Handheld Device Only Ownership in Public Use Microdata Areas within Atlanta and Washington, DC Metropolitan Statistical Areas**

|  | Owns Handheld Device | Owns Handheld Device Only |
|---|---|---|
|  | *Percent* | *Percent* |
| **Atlanta-Sandy Springs-Roswell, GA** |  |  |
| Minimum | 59.6 | 1.2 |
| Maximum | 96.2 | 16.1 |
| PUMAs above national average | 73.3 | 20.0 |
| PUMAs no different from national average | 13.3 | 46.7 |
| PUMAs below national average | 13.3 | 33.3 |
| **Washington-Arlington-Alexandria, DC-VA-MD-WV** |  |  |
| Minimum | 65.8 | 0.9 |
| Maximum | 95.2 | 17.0 |
| PUMAs above national average | 80.9 | 10.6 |
| PUMAs no different from national average | 12.8 | 27.7 |
| PUMAs below national average | 6.4 | 61.7 |

Source: U.S. Census Bureau, American Community Survey, 2015.
For information on confidentiality protection, sampling error, nonsampling error, and definitions, see *https://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/ACS_Accuracy_of_Data_2015.pdf* .

Turning to handheld-only ownership, values range between 1 and 16 percent for Atlanta PUMAs and between 1 and 17 percent for DC-area PUMAs. Looking at Atlanta more closely, just as handheld-only ownership was similar to the national average (8 percent) for the MSA overall, this is true for a majority (47 percent) of Atlanta-area PUMAs. Another 20 percent of Atlanta PUMAs have above-average

levels of having a handheld only, and about a third fall below the national average. A greater share of DC-area PUMAs, at 62 percent, has below-average levels of handheld-only ownership, and only 11 percent have values above the national average. Thus, DC-area households not only are more likely than those in the Atlanta area to own handhelds, but also are more likely to have more than one type of device that can connect to the Internet.

*Maps.* PUMA-level maps of handheld ownership and handheld-only ownership help to further visualize geographic differences within the Atlanta and Washington, DC metro areas. In particular, mapping allows comparisons both within the more urban part of the MSAs as well as between the urban core and more suburban/rural portions.

Figure 1 shows the percentage of households owning a handheld device, for PUMAs partially or entirely within the Atlanta-Sandy Springs-Roswell metro area. The gray lines indicate PUMA boundaries, and the blue line indicates the boundary of the Atlanta MSA. Darker shades denote higher levels of handheld ownership.

First, lack of Internet-capable devices is often thought of as a rural issue, and there is evidence of that here. The more outlying Atlanta PUMAs appear lighter on the map, indicating they have lower percentages of handheld ownership compared with the more urban core. For example, about 67 percent of households own handheld devices in the PUMA including Heard and Meriwether counties. In the PUMA including the north part of Atlanta, including well-to-do Midtown, 91 percent of households own handheld devices. [12] However, there is also variation in handheld ownership within Atlanta's urban core. Only 66 percent of households in the PUMA containing central Atlanta have handheld devices, different from the north part of the city bordering it.

As seen in earlier results, race and poverty status are important for understanding handheld ownership. The racial and class composition of PUMAs helps explain variation in handheld ownership. For example, north Atlanta has a low share of households below poverty, at 6 percent, and few black-headed households, at 14 percent. In contrast, 22 percent of homes in Heard and Meriwether counties and 32 percent of homes in central Atlanta are below poverty. About a third of households in Heard and Meriwether counties and 91 percent of those in central Atlanta have a black householder.

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[12] See http://www.areavibes.com/atlanta-ga/neighborhoods/.

**Figure 1. Percentage of Households Owning a Handheld Device:  Atlanta-Sandy Springs-Roswell Metro Area**
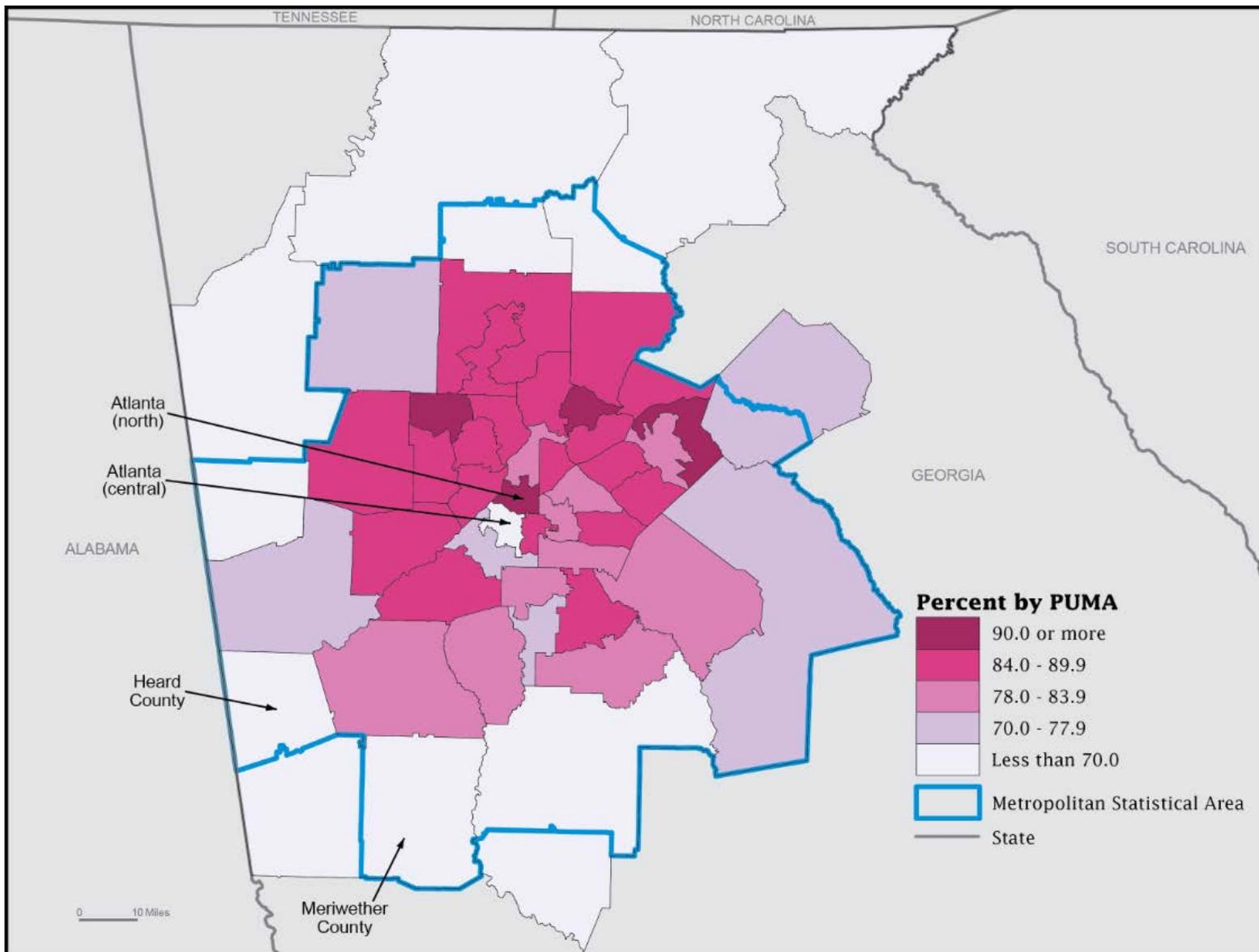


Source: U.S. Census Bureau, American Community Survey, 2015.
For more information, see *https://www.census.gov/acs*.

**Figure 2. Percentage of Households Owning a Handheld Device:  Washington-Arlington-Alexandria Metro Area**
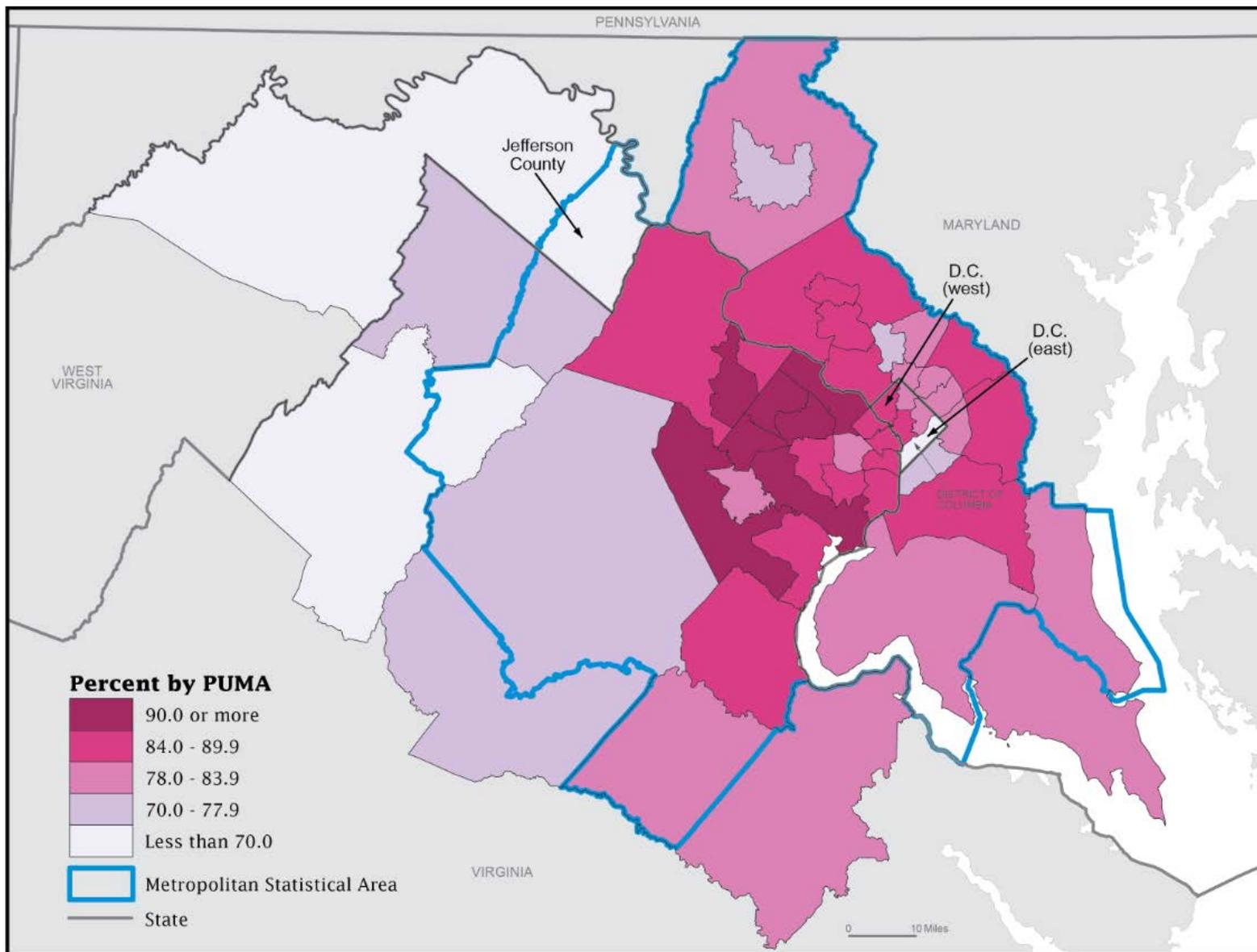
19

The percentage of households owning a handheld device, for PUMAs partially or entirely within the Washington-Arlington-Alexandria metro area, is shown in Figure 2. As we saw for Atlanta, there is variation both between more rural and urban portions of the MSA and within the core urban area. Comparing the PUMA containing Jefferson county, WV with west DC highlights rural-urban differences. Note that the west DC PUMA contains well-known, affluent neighborhoods such as Georgetown and Cleveland Park.[13] About 68 percent of homes in the PUMA containing Jefferson county own handheld computers, compared with 90 percent of homes in west DC.

A noteworthy contrast within the urban portion of the MSA is between west and east DC. The east DC puma is the portion of DC east of the Anacostia River, and includes neighborhoods such as Anacostia and Deanwood, which have unfavorable reputations.[14] Only 69 percent of households in east DC own handheld devices.

Similar to Atlanta, class and racial composition of DC-area PUMAs ties in with handheld ownership. Poverty is low in west DC, at 6 percent. About 13 percent of households in the PUMA containing Jefferson county and 29 percent of those in east DC fall below poverty. Although west DC and Jefferson county do not differ in terms of black-headed households, the share of homes with a black householder is higher in east DC, at 93 percent, compared with west DC, at 8 percent.

Staying for a moment with the Washington, DC MSA, Figure 3 displays the percentage of households owning a handheld device only, by PUMA. For much of the area, this map is a mirror image of the map depicting overall ownership, as many PUMAs with darker colors on Figure 2 appear lighter here, and vice versa. This suggests that high levels of overall ownership tend to be paired geographically with low levels of handheld-dependence, and areas with low levels of ownership tend to have greater reliance on handhelds. For example, focusing on the same PUMAs as before, 8 percent of households within Jefferson county and 17 percent in east DC rely upon their handheld devices for Internet access, compared with only 1 percent of those in west DC.

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[13] See http://www.areavibes.com/washington-dc/neighborhoods/.

[14] Once more, see http://www.areavibes.com/washington-dc/neighborhoods/.

**Figure 3. Percentage of Households Owning a Handheld Device Only: Washington-Arlington-Alexandria Metro**
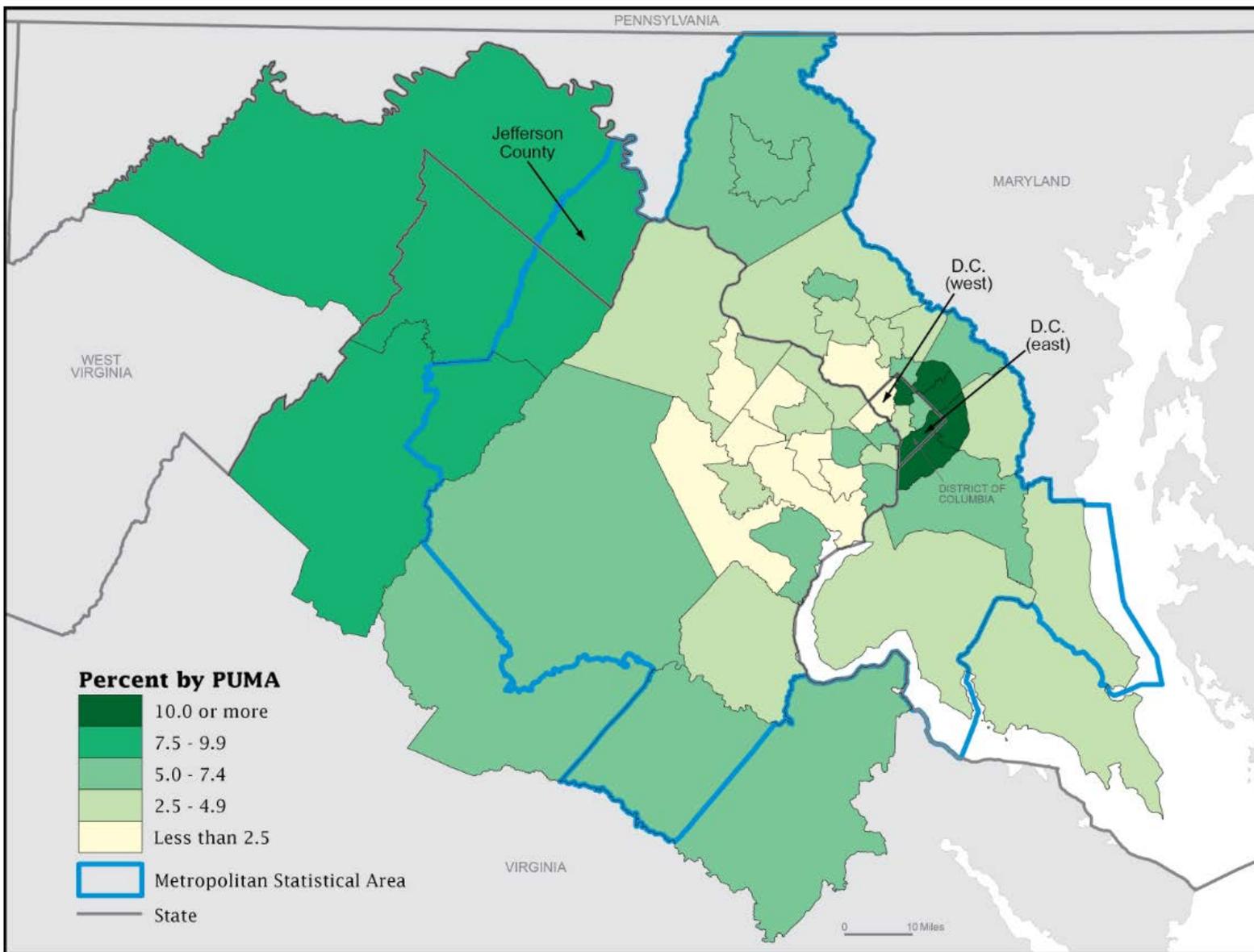


Source: U.S. Census Bureau, American Community Survey, 2015.
For more information, see *https://www.census.gov/acs*.

**Figure 4. Percentage of Households Owning a Handheld Device Only:  Atlanta-Sandy Springs-Roswell Metro Area**
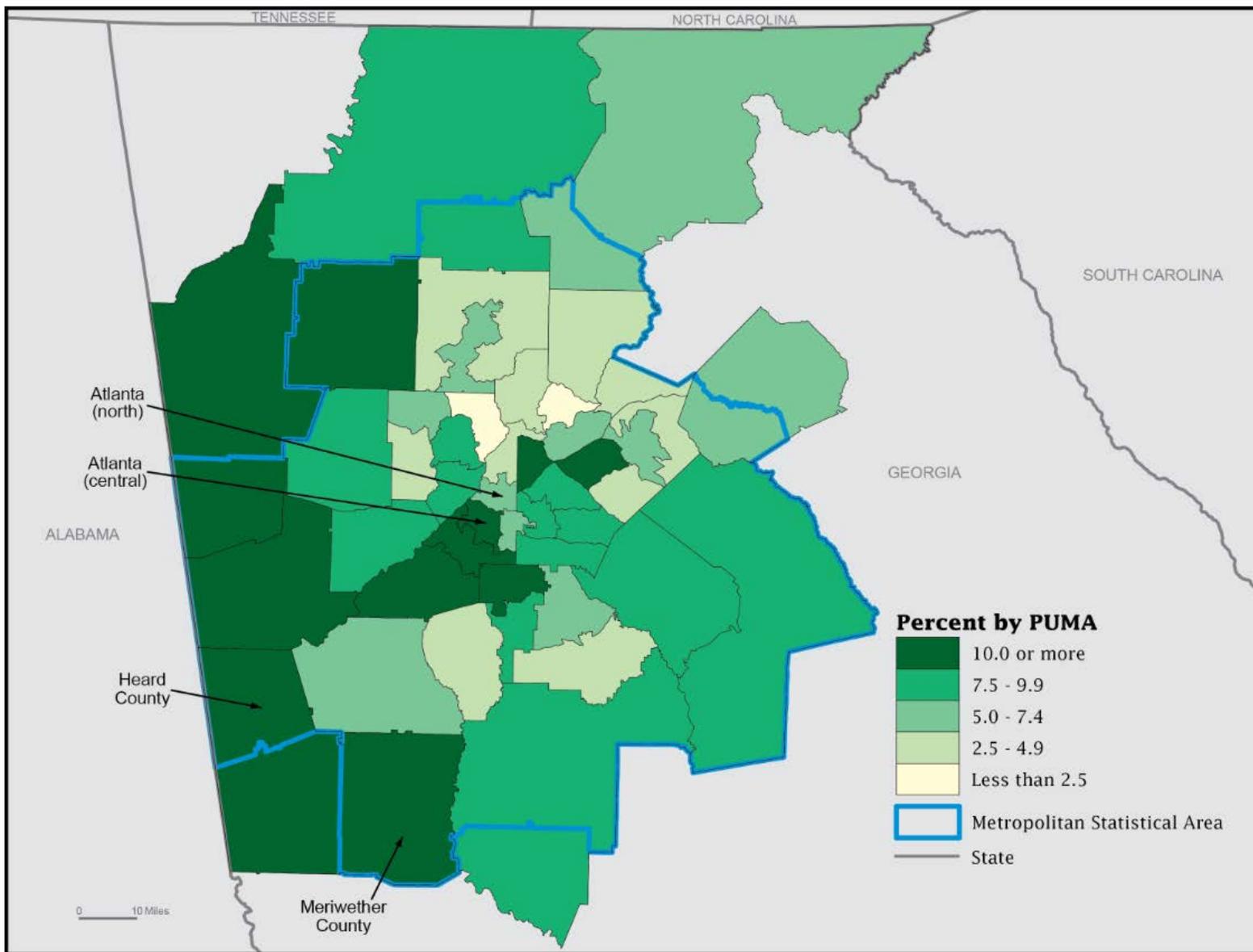
Finally, the share of Atlanta households owning a handheld device only, by PUMA, is shown in Figure 4. Similar to what was seen for the DC area, comparing this map with that for overall ownership in the Atlanta MSA (Figure 1) shows that areas with higher values on overall ownership tend to have lower values of handheld dependence. For instance, only about 5 percent of north Atlanta homes have handhelds as their only Internet-capable device, compared with 15 percent of homes in Heard and Meriwether counties and 16 percent of those in central Atlanta.[15]

**CONCLUSION**

Decreasing the digital divide, or gap between those who have and want for ready access to computers and the Internet, is key for promoting equal opportunities for all. The Internet is used to connect to a great number of services and accomplish a variety of tasks, from social networking and e-mail to applying for government services and jobs (Smith 2015). Americans are more and more likely to see high-speed Internet access as a crucial tool for seeking information relevant to their lives (Horrigan and Duggan 2015).

Smartphones and mobile broadband have the potential to spread Internet access more widely and benefit less-connected groups, as those with lower rates of access overall are more likely to own a handheld device only (File and Ryan 2014). However, when thinking about how smartphones mitigate or exacerbate the digital divide, it is important to consider both overall ownership and handheld dependence. That is, for those who are reliant on handheld devices for Internet access, higher rates of handheld ownership are needed to make reductions to the digital divide.

In the current study, I used data from the 2015 ACS to examine characteristics related to and geographic variation in owning a handheld device and owning a handheld device only. Results suggest that the digital divide is particularly stark for several groups including Blacks, Hispanics, those of some other race, below-poverty households, homes without children, those with low English proficiency, those with lower levels of education, the unemployed, people with disabilities, those residing outside a metropolitan/micropolitan area, and those living in rural areas. Each of these groups is both less likely to own a handheld device and more likely to be dependent on these devices for Internet access. Consistent

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[15] The estimates for Heard and Meriwether counties versus central Atlanta are not statistically different.

with prior research (Smith 2015), I find that handhelds are the preferred devices for younger age groups, as greater reliance on these devices is complemented by higher ownership.

In addition to overarching geographic characteristics, I find that geography matters for handheld device ownership in subtler ways. Handheld ownership is more common among households in the Atlanta and Washington, DC metro areas than for the nation as a whole, and the DC area also has a lower rate of handheld-only ownership. However, there is important variation within both MSAs, with some parts having less access to handheld devices and/or being more reliant on these devices. These disadvantages are observed for a greater share of Atlanta-area households than DC-area households. PUMA-level maps demonstrate that more outlying portions of the Atlanta and DC MSAs tend to be more disadvantaged relative to those in the urban core, being both less likely to own a handheld device and more likely to depend on these devices for Internet connectivity. However, there is also variation within the urban core, as PUMAs with higher levels of poverty and black-headed households are more impacted by the digital divide. Although the present study only demonstrates these differences for the Atlanta and Washington, DC metro areas, it is possible that similar patterns are repeated for other MSAs across the country.

Finally, although there is potential for smartphones to increase Internet connectivity among those groups most in need of access, this strategy is not without limitations. First, whereas home broadband users enjoy unlimited Internet access as part of their monthly subscription, many cellular data plans are subject to data caps. Second, despite the sweeping advances being made in smartphone functionality, the capabilities of handheld versus conventional devices continue to differ. Mobile processors are slower than those found in personal computers (PCs), and smartphones currently cannot compete with PCs in terms of efficiency, battery capacity, or storage (Smith 2013). Handheld devices' smaller screens can also pose limitations for some uses (Anderson and Horrigan 2016). Thus, although smartphones and mobile broadband offer one route to reducing the digital divide, they may not provide a complete answer.

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