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Who perceived automation as a threat to their jobs in metro Atlanta: Results from the 2019 Metro Atlanta Speaks survey

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ARTICLE INFO

Keywords:
Automation
Metro Atlanta speaks survey
Regression analysis
Technological progress
Unemployment

ABSTRACT

While ethnic minorities, less-educated or less-skilled workers, and low-income workers are, in general, deemed more vulnerable to automation, the literature has not adequately investigated whether or not these sociodemographic groups perceive automation as a threat to their jobs. Using the 2019 Metro Atlanta Speaks survey, we find that high-income residents and residents with a graduate or a professional degree did not perceive automation as a threat to their jobs, but relatively older residents, blacks or African Americans, and low-income residents perceived automation as a threat to their jobs. Although Hispanics or Latinos and less-educated residents are identified to be more vulnerable to automation, they did not perceive automation as a threat to their jobs. Hence, automation is most likely to make Hispanics or Latinos and less-educated residents unemployed in metro Atlanta as they do not perceive automation as a threat to their jobs despite being deemed more vulnerable to automation.

1. Introduction

While technological progress, in general, improves efficiency and increases labor productivity, it also increases unemployment risk in society as it eliminates several jobs or occupation families employing less-skilled or less-educated workers. One such example of technological progress threatening many jobs or occupation families is job automation. A most recent study by the Brookings Institution indicates that one-quarter of the United States (U.S.) employment in 2016 (36 million jobs) are expected to experience automation by 2030, with more than 70% of current tasks at the risk of automation in the coming decades. Another 36% of employment in 2016 (52 million jobs) are expected to experience “medium exposure” to automation by 2030 [1]. It is almost sure that automation, to some extent, will impact every occupation, but the severity of this impact will vary across sociodemographic groups. While previous studies have indicated that less-educated or less-skilled workers, ethnic minorities, or low-income workers are, in general, more vulnerable to automation, compared to other sociodemographic groups [1–5], the literature has not adequately investigated whether or not workers who are deemed vulnerable to automation perceive automation as a threat to their jobs, and none has focused on metro Atlanta region of the U.S. state of Georgia. In this study, we take a deep dive into the 2019 Metro Atlanta Speaks survey to understand the sociodemographic characteristics of employed residents who perceived automation as a threat to their jobs in metro Atlanta.

Technological developments, in general, favor skilled or more educated workers [5]. Hence, less-educated or low-skilled, low-income, or younger workers are more likely to be displaced due to automation [1,3,6–8]. For instance, waiters and waitresses, food serving workers, retail salespersons, cashiers, and office clerks are the types of jobs that are at a higher risk of automation in the future [1]. Note that these are the jobs employing a higher percentage of younger, less-educated, or low-skilled workers in the U.S. [6]. If jobs involve repetitive functions with very minimal human interactions, those jobs are also at high risk of being automated in the future [7–9]. For instance, warehouse tasks, such as data collection, software operations, inventory control, and inventory distribution and documentation involve repetitive tasks and also do not require any human interactions, in most of the cases. Accordingly, warehouse-related jobs are expected to be increasingly automated in the future. In many cases, low-paying jobs comprise repetitive functions, making these jobs more vulnerable to automation. The U.S. Council of Economic Advisers (2016) estimated that jobs paying less than $20 an hour have an 83% probability of being automated in the coming decades [10]. Regarding demographic characteristics, males and non-white ethnic groups (e.g., blacks or African Americans, Hispanics or Latinos, or American Indians) are deemed to be more vulnerable to automation.

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https://doi.org/10.1016/j.techsoc.2020.101368
Received 28 January 2020; Received in revised form 13 August 2020; Accepted 29 August 2020
Available online 30 August 2020
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because of the nature of the job or occupation family involved and the prevalent sociodemographic characteristics of the typical worker in that occupation family [1,6].

In this study, we investigate the sociodemographic characteristics of employed residents who perceived automation as a threat to their jobs in metro Atlanta. This study is timely and policy-relevant for several reasons. The metro Atlanta is the economic capital of the Southeast region in the U.S. and is headquarters for the 26 Fortune 1000 companies, generating a combined $415 billion of aggregate revenue in 2018 [11]. Compared to other peer metro regions, metro Atlanta’s business climate is more investment-friendly, and a recent study from the personal finance website WalletHub (2019) ranks metro Atlanta among the fastest-growing cities in the U.S., based on the metro’s sociodemographic characteristics, including, job openings and the strength of the local economy [12]. The ten core counties in metro Atlanta have nearly 2.4 million workers, and job growth in metro Atlanta is relatively stronger compared to the nation. Healthcare, information technology, transportation and logistics, manufacturing, finance, and tourism and hospitality are the major sectors or occupation families providing employment opportunities for thousands of residents in metro Atlanta. However, owing to the sociodemographic characteristics of workers, jobs in several occupation families that offer employment opportunities to thousands of low-skilled or less-educated workers are at risk of being automated in the future.

Metro Atlanta has a relatively larger percentage of younger, less-educated, or low-income workers. The CHMURA JobsEQ (2019) labor demand tool estimates that 36% of metro Atlanta’s workers are under 35 years (16–34 years) old, 60% are between 35 and 64 years old, and the remaining 4% are over 65 years old in 2018. Twenty-eight percent of the workers have a high school or less education, 29% have some college or an associate’s degree, and 43% have a bachelor’s degree or more. Nearly forty-four percent of the workers are whites, 36% are blacks or African Americans, 11% are Hispanics or Latinos, and 9% are other race/ethnic groups, and 52% are male. Nearly 800,000 people (33% of the workforce) work in occupation families that have 50% or higher probability of automation in the coming decades or so [13]. Note that office and administrative support; transportation and material moving; food preparation and serving related; construction and extraction; production operation; and farming, fishing, and forestry are identified as the occupations where automation risk is estimated at 50% or more in the coming decades [1]. While the average annual wage rate across all occupations in metro Atlanta is nearly $52,000, it is nearly $37,000 in the occupation families where automation risk is estimated to be 50% or more in the coming decades [1,13].

As we discussed earlier, low-skilled or less-educated workers, low-wage workers, males, and ethnic minorities are deemed to be more vulnerable to automation than their counterparts. In this regard, the findings of this study will be valuable information in understanding whether or not metro Atlanta residents who are deemed to be more susceptible to automation perceived that they are indeed subject to automation. Agencies working in workforce development such as the Atlanta Regional Workforce Development Board may find these findings useful to tailor the agency’s existing workforce development policy to mitigate any automation-induced disruption in the labor market in the future. For instance, the agency may use these findings to target outreach efforts to certain sociodemographic groups who do not perceive automation as a threat to their jobs despite being identified as more susceptible to automation, as well as to educate them about the negative consequences of automation, such as the possibility of being unemployed. The agency may offer training opportunities or provide information about training opportunities to these sociodemographic groups and so mitigate the automation-induced disruption in the labor market. Also, addressing these issues would help improve racial equity as non-whites (e.g., blacks or African Americans, Hispanics or Latinos, or other racial groups) are, in general, more susceptible to automation than the white counterpart.

The rest of this paper proceeds as follows. Section 2 revisits the theoretical links between automation and unemployment. Section 3 describes the methods used to identify the sociodemographic characteristics of employees who perceived automation as a threat to their jobs in the future. Section 4 summarizes the results, and the last two sections discuss the findings and provide study conclusions.

2. Automation and unemployment: revisiting the theoretical links

The literature on job automation and unemployment is relatively new, and there is no consensus among economists and social scientists on how the future looks like in the age of intelligent technologies or the digital economy. Some argue that the new technology will disrupt the labor market by displacing thousands of workers, in particular, those who are less-educated or less-skilled. The transition of these displaced workers to other sectors is limited by the skill gap and mismatch between the place they live and job availability. Hence, technology is likely to make these workers unemployed [1,3,7,14]. In contrast, some see a brighter future with smart technologies as it can bring multiple opportunities for growth and employment, particularly in the long run [15–17]. Shoook and Knickrehm (2018) estimates that artificial intelligence alone could boost revenues by 38% and jobs by 10% by 2022, provided that there are sufficient investments in intelligent technologies and human-machine collaborations [18].

The concern that technology can make workers unemployed is, in fact, not a novel concern in economics as J.M. Keynes introduced the term “technological unemployment” during the Great Depression. According to Keynes, technology can make workers unemployed in the short-run because technical efficiency increases faster than labor absorption in the economy. The economy adjusts with this mismatch in the long-run, and accordingly, there is no technological unemployment in the long-run, and intelligent technologies instead bring opportunities for growth [19]. However, this notion has come under scrutiny as a number of recent studies have estimated that millions of jobs currently performed by less-educated or less-skilled workers are at risk of automation in the coming decades [1,3,7,20]. Moreover, because of the skill or geography mismatch, these less-educated or less-skilled workers are less likely to be absorbed in other sectors. Hence, technology is expected to disrupt the labor market by eliminating thousands of blue- and white-collar jobs currently performed by less-educated or less-skilled workers, ranging from truck drivers and warehouse workers to telephone operators to insurance agents to health-care managers.

The literature, in general, uses a macroeconomics approach to analyze the potential impact of automation on jobs. In any economy, final goods (P) are produced using capital (K) and labor (L) as inputs, as specified in equation (1).

$$ P = f(K, L) $$

In the traditional economic analysis, technology is assumed to take a “factor-augmenting” role rather than substituting labor. Hence technological changes multiply K and L in equation (1).

$$ P = f(AK, BL) $$

In equation (2), A and B are factor-augmenting parameters for K and L, respectively. If technological change is capital augmenting (technological change increases A), it does not cause any unemployment. In contrast, if technological change is labor augmenting (technological change increases B), it does cause unemployment so long as the elasticity of substitution between capital and labor is small [12]. Besides augmenting factor parameters, technological changes can also substitute labor directly, resulting in job losses. For instance, if capital is sufficiently cheap or productive at the margin, automation will substitute capital for labor, displacing workers from the tasks that are being automated. This displacement can cause a decline in labor demand and hence wages. However, automation can create a positive

$$ L = f(AK - BL) $$
impact on labor demand due to countervailing effects – productivity effect, new tasks, and capital accumulation [16,17]. When production of goods and services is increasingly automated, goods and services become cheaper and are of better quality. In other words, there will be a productivity effect in the economy. This productivity effect leads consumers to demand more and, accordingly, increases labor demand. When new technology is introduced, resulting in a productivity effect, new tasks or activities emerge in the economy, creating new job opportunities. According to Acemoglu and Restrepo (2016), the creation of new tasks explains almost half of all employment growth in the U.S. between 1980 and 2000 [18]. As automation increases demand for capital, it leads to capital accumulation in the long run, raising the demand for labor. Olmstead and Rhode (2001) argue that rapid capital accumulation was the channel of adjustment of the American economy in the face of mechanization of agriculture in the first half of the 20th century [21]. Fig. 1 summarizes the relationship between technology and unemployment.

While the substitution effect may dominate in the short run, causing labor displacement, the productivity effect is always strong enough, at least to offset the substitution effect in the long run [16,22,23]. However, during the transition period, unemployment may rise despite strong countervailing effects to offset automation-induced displacement [24,25]. Although automation creates new jobs, these new jobs may require different skills or could be located in different locations compared to jobs that got disappeared or are transformed as a result of automation. Hence, automation can make workers unemployed during the transition. According to Bessen (2018), if the productivity effect is strong enough to increase product demand from automated industries, employment in these industries can grow even after automation. For instance, employment in U.S. manufacturing industries had grown despite automation in the past (e.g., until the 1930s for textiles and the 1950s for steel) [17]. If automation in one industry creates a positive externality in other industries (e.g., increasing demand in other industries), workers would need to shift from the automated industries to other industries to get employed [26]. Again, the transition from the automated industries to other industries may be constrained by the skill gap (e.g., skill mismatched – the skills possessed by displaced workers and skills in demand in the market) and geography mismatch – the place where workers live and jobs are available.

Education is regarded as a leading indicator of automation risk as several studies have constantly shown a strong and negative correlation between the level of education and automation risk [1,27]. Also, a higher level of education helps to narrow down the skill gap in the market. According to Accenture (2019), 74% of highly automatable occupations in the U.S. are predominantly held by employees without a bachelor’s degree [27]. Hence, less-educated or less-skilled workers are expected to be displaced in the future for several reasons. As the economy becomes more digital, the prospect of maintaining employment becomes less attractive to employers because programming software can do many tasks currently performed by human workers more efficiently (e.g., cheaply and more accurately). Further, computer technology is becoming cheaper than human labor, and it has improved its capabilities to perform various tasks more efficiently with little or no human interactions [28]. As workers are often not hired on a permanent basis but on-demand, automation is argued to change in employment relationships, and this situation can make both high- and low-skilled workers unemployed [29,30]. Hence, jobs such as paralegal professions, retail salespersons, waiters, office clerks, accountants, insurance agents, and waiters and waitresses are expected to be automated in the coming decades [1,7]. Again, the transition of these less-educated workers to other sectors (e.g., sectors where job opportunities are created because of automation) is limited by skill gap and geography mismatch. Hence, technology-induced disruption in the labor market can make less-educated or less-skilled workers unemployed. These displaced workers may become discouraged and eventually drop out of the labor force if intervention is not designed timely.

Automation-prone industries or jobs (e.g., retail salespersons, cashiers, office clerks, accountants, insurance agents, and waiters and waitresses) are characterized by historically a large share of young workers in their workforce, making these young workers more vulnerable to automation in the future. According to a Brookings Institution study, half of the tasks currently performed by workers who are 16–24 years old can be automated over the next decades, compared to 40% of the tasks of older workers [1]. Although there is no consensus among economists regarding the potential impact of automation by gender in the future (see Ref. [31]), historical trends indicate that male workers can be more vulnerable to automation in the future because of the nature of jobs traditionally represented by male workers (e.g., men are over-represented in manufacturing, production, transportation, and construction jobs in the U.S. [1]). It is estimated that 43% of jobs currently performed by male workers in the U.S. could be automated by 2040, compared to 40% of women’s jobs [1]. Regarding race/ethnicity, ethnic minorities can be more vulnerable to automation in the future because of their historical underrepresentation in fast-growing, high-paying directive roles [2]. According to Muro, Maxim, and Whiton (2019), 47% of the jobs currently performed by Hispanics or Latinos, and 44% of the jobs currently performed by blacks or African Americans are automatable in the next two decades in the U.S. compared to 40% of the jobs currently performed by whites [1]. The reviews indicate that employees’ sociodemographic characteristics are important predictors of automation risk. Because of the differences in employees’ sociodemographic characteristics, their perceptions about automation as a threat to their jobs could be different. We use the 2019 Metro Atlanta Speaks survey to understand the sociodemographic characteristics of employed residents who perceived automation as a threat to their jobs in metro Atlanta.

3. Method

3.1. Metro Atlanta Speaks survey

Data for this study came from the Metro Atlanta Speaks (MAS) survey conducted in 2019 [34]. The MAS survey is an ongoing regional opinion survey conducted by the Atlanta Regional Commission (ARC), the planning agency for the metro Atlanta region, in collaboration with its community partners. Inspired by the Kinder Institute’s Houston Area Survey in Texas, ARC has been conducting the MAS survey annually since 2013. The goal of the MAS survey, in general, is to assess residents’ attitudes and opinions on various critical issues, including transportation and mobility, the local economy, public education, and amenities and the quality of life. However, each year’s survey includes some additional questions or issues that just emerged in metro Atlanta. For example, questions related to financial resilience, food insecurity, and challenges faced in accessing transportation were added in the 2016 survey; questions related to housing and affordability were added in the 2018 survey; and questions related to workforce development were added in the 2019 survey [35,36].

The MAS survey is a random-digit-dialed telephone survey of residents, aged 18 years and older, living in the households in the 13-county – Butts, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglas, Fayette, Fulton, Gwinnett, Henry, Paulding, and Rockdale – in metro Atlanta [34,37]. The survey is conducted using a computer-aided telephone interviewing system, which randomly selects the telephone numbers to be contacted for an interview. Upon hearing someone answering the call, the interviewer asks about the number of people who are at least 18

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1 For instance, over two-third of the manufacturing workers are male in the U.S. and manufacturing sectors have experienced rapid automation in the past decades [7,22].

2 Rice and Winter (2019) reports significant gender differences where females are less willing than males to use new technology [33].
years older in the household and seeks to interview the person with the most recent birthday. The 2019 MAS survey sought to collect opinions from at least 5,400 residents who live in the households in the 13-county metro Atlanta region. The A.L. Burruss Institute at Kennesaw State University has been conducting the survey since 2016 [34]. The survey instruments, results, interactive dashboard, and main highlights of the 2019 Metro Atlanta Speaks survey are available at https://atlantaregion.technology/atlanta-region/regional-data-resources/metro-atlanta-speaks-survey-report/.

Like the previous year’s survey, the core part of the 2019 MAS survey was a series of questions related to residents’ opinions or perceptions on various critical issues facing by the metro Atlanta region or its residents. One question in the survey asked employed residents whether or not they perceive automation as a threat to their jobs. In particular, employed residents were asked whether or not they agree with the statement: “I am worried that I may lose my job to some type of automated process” with the five possible response options to be chosen - strongly agree, agree, disagree, strongly disagree, or do not know. An automated process was defined as the use of technology to perform jobs partly or fully with little or no human interventions but currently performed by humans. Some examples of the automated process include but are not limited to self-checkout kiosks or mobile apps in departmental stores, fast foods, and restaurants, virtual assistants to perform various tasks, automation in accounting, and various forms of technology used in production or distribution process. The variable automation threat \((A_{ij})\) equals one if the respondent agreed (strongly agreed or agreed) with the statement: “I am worried that I may lose my job to some type of automated process,” and zero otherwise [34].

The survey also collected a number of sociodemographic characteristics of the respondents, including their age, race/ethnicity, gender, education, employment, annual household income, years of tenure in metro Atlanta, living north/south of Interstate 20, homeownership, and home zip code. All survey responses are anonymous since the survey does not ask any identifiable personal information [35,36].

3.2. Empirical model

We model the response of the resident ‘i’ who lives in zip code ‘z’ on whether or not he/she perceived automation as a threat to his/her job (automation threat) \((A_{iz})\) to depend on his/her sociodemographic characteristics \((S_{iz})\) while controlling for the zip code fixed effects \((\alpha_z)\) in the model, as specified in equation (3):

\[
A_{iz} = f(S_{iz}; \alpha_z)
\]  

(3)

As we discussed earlier, several jobs or occupations currently typically performed by males, non-whites, less-educated, or low-income residents are at higher risk of being automated in the coming decades [1,7]. Accordingly, we account for age, gender, race/ethnicity, education, and income of the residents. We also account for tenure length in metro Atlanta in the model to see how residents with different tenure lengths perceive automation as a threat to their jobs. Homeownership status is also accounted for in the model to assess whether respondents with homeownership perceive automation as a threat to their jobs differently than renters. The northern and southern parts of metro Atlanta differ significantly on the quality of life or physical development indicators, and this north-south dividing line roughly parallels Interstate 20 (I-20). For example, many high-paying jobs are clustered in the northern part of the region, while the vast majority of economically distressed areas are in the southern part. Many suburbs in the northern part are white-dominated, while many suburbs in the southern part are black or African American-dominated [38]. Accordingly, we account for whether the respondent lives north or south of I-20 in the model.

The zip code fixed effects \(\alpha_z\) are included in the model to account for zip code-specific unobserved heterogeneities influencing residents’ perceptions about automation. Locations represented by the zip codes in
metro Atlanta vary significantly across a number of community indicators, such as income or wealth, quality of life, occupations, and physical development. For instance, residents living in distressed areas or areas having many low-wage jobs are expected to perceive automation as a threat to their jobs because of their sociodemographic characteristics. Accounting for the zip code fixed effects also controls for heterogeneities in physical development (e.g. road access and mobility, proximity to transit and recreation areas, and access to jobs) across communities as represented by zip codes. The use of zip code fixed effects mitigates the omitted variable bias, and hence, endogeneity concern in the regression model as it accounts for unobserved heterogeneities (e.g., zip code level variables) influencing residents’ perception about automation and job loss [36].

Since we model automation as a threat perceived by respondents as a binary choice (it equals 1 if the respondent strongly agreed or agreed with the statement: “I am worried that I may lose my job to some type of automated process,” and zero otherwise), logistic regression is used to estimate the model (eq. (1)) [39]. The logistic regression model may be written in equation (4).

\[
\ln \left( \frac{P(Y_i = 1)}{1 - P(Y_i = 1)} \right) = \ln(\text{Odds}_i) = \alpha + \sum_{k=1}^K \beta_k X_{ik} = \alpha + \beta X
\]

In the equation above, \( X \) is the vector of explanatory variables (\( S \) and \( \alpha \)) and \( \beta \) is the vector of parameters to be estimated [40]. Stata 14.2 was used to estimate the model.

4. Results

4.1. Sample description

The 2019 Metro Atlanta Speaks survey collected responses from 5450 residents who live in the 13 counties in the metro Atlanta region. Among them, a total of 2715 residents were employed full-time or part-time [24]. However, because of missing observations in one or the other covariates, we use responses provided by 1751 residents for this analysis. In the dataset, 9% of the respondents indicated they are worried that some type of automated process, might result in bias and incorrect estimates [41]. The regression analysis uses metro weights, based on the 2010 Census, to mitigate this bias. The metro weights adjust for responses of individuals, based on their demographic profiles in metro Atlanta (e.g. gender, age, education, and race/ethnicity) [34,35].

The presence of multicollinearity among covariates in the model can increase the variance of estimates, resulting in imprecise estimates [42]. We estimate the variance inflation factor (VIF) to test for

| Variable | Description | Mean | VIF |
|----------|-------------|------|-----|
| Automation threat | A binary variable that equals one if the respondent strongly agreed or agreed with the statement: “I am worried that I may lose my job to some type of automated process,” and zero otherwise | 0.09 | Dependent variable |
| Age group (base: 18–34 years) | | | |
| 18–34 years | A binary variable that equals one if the respondent belonged to the 18–34 years age group, and zero otherwise | 0.19 | Base category |
| 35–49 years | A binary variable that equals one if the respondent belonged to the 35–49 years age group, and zero otherwise | 0.31 | 2.04 |
| 50–64 years | A binary variable that equals one if the respondent belonged to the 50–64 years age group, and zero otherwise | 0.40 | 2.25 |
| 65 years or older | A binary variable that equals one if the respondent was 65 years or older, and zero otherwise | 0.10 | 1.16 |
| Male | A binary variable that equals one if the respondent was male, and zero otherwise | 0.49 | 1.99 |
| Race/ethnicity | | | |
| White | A binary variable that equals one if the respondent was white, and zero otherwise | 0.54 | Base category |
| Black or African American | A binary variable that equals one if the respondent was black or African American, and zero otherwise | 0.33 | 1.84 |
| Other Race | A binary variable that equals one if the respondent was other race, and zero otherwise | 0.13 | 1.41 |
| Hispanic or Latino | A binary variable that equals one if the respondent was Hispanic or Latino, and zero otherwise | 0.05 | 1.48 |
| Education | | | |
| H.S. grad or less | A binary variable that equals one if the respondent had a high school degree or less, and zero otherwise | 0.13 | 2.15 |
| Some college | A binary variable that equals one if the respondent had some college or an associate degree, and zero otherwise | 0.31 | 2.01 |
| College degree | A binary variable that equals one if the respondent had a college degree, and zero otherwise | 0.32 | Base category |
| Grad/ professional degree | A binary variable that equals one if the respondent had a graduate or a professional degree, and zero otherwise | 0.25 | 1.52 |
| Income | | | |
| < $25 K | A binary variable that equals one if the respondent had a household income $25,000 or less, and zero otherwise | 0.04 | 1.36 |
| $25 K – $60 K | A binary variable that equals one if the respondent had a household income between $25,000 and $60,000, and zero otherwise | 0.19 | 1.71 |
| $60 K – $120 K | A binary variable that equals one if the respondent had a household income between $60,000 and $120,000 a year, and zero otherwise | 0.40 | Base category |
| $120 K-$250 K | A binary variable that equals one if the respondent had a household income between $120,000 and $250,000 a year, and zero otherwise | 0.30 | 1.69 |
| $250 K or more | A binary variable that equals one if the respondent had a household income $250,000 or more, and zero otherwise | 0.06 | 1.16 |

(continued on next page)
residents with a high school degree or less education had 54% lower odds to perceive automation as a threat to their jobs. Residents who have a graduate or a professional degree had higher odds to perceive automation as a threat to their jobs, compared to the non-Hispanic or Latino counterparts. Compared to residents who have a college degree, those with annual household income between $60,000 and $120,000 had 85% higher odds to perceive automation as a threat to their jobs, compared to those with annual household income is $25,000 or less. Residents who are 50–64 years old had 168% higher odds, and residents who are 65 years or older had 218% higher odds, compared to whites, blacks or African Americans had 128% higher odds to perceive automation as a threat to their jobs. Residents with annual household income $25,000 or less had 85% higher odds to perceive automation as a threat to their jobs. Blacks or African Americans whose annual household income is $25,000 or less were less likely to perceive automation as a threat to their jobs. Blacks or African Americans whose annual household income is between $120,000 and $250,000 were more likely to perceive automation as a threat to their jobs. Nevertheless, blacks or African Americans whose annual household income is between $120,000 and $250,000 were more likely to perceive automation as a threat to their job (column 5). The decision criteria for hypothesis testing are based on $p < 0.10$.

Residents who are 50–64 years old had 168% higher odds, and residents who are 65 years or older had 175% higher odds to perceive automation as a threat to their jobs compared to residents who are 18–34 years old. Compared to whites, blacks or African Americans had 128% higher odds to perceive automation as a threat to their jobs. Residents with annual household income $25,000 or less had 85% higher odds to perceive automation as a threat to their jobs, compared to those with annual household income between $60,000 and $120,000. However, Hispanic or Latino residents had 72% lower odds of perceiving automation as a threat to their jobs, compared to the non-Hispanic or Latino counterparts. Compared to residents who have a college degree, residents with a high school degree or less education had 54% lower odds and residents who have a graduate or a professional degree had 59% lower odds to perceive automation as a threat to their jobs. Residents with annual household income $250,000 or more had 91% lower odds to perceive automation as a threat to their jobs, compared to those with annual household income between $60,000 and $120,000.

4.2.2. Who perceived automation as a threat to their jobs: exploring interaction effects

We explore the interaction effects to see how residents with a combination of various sociodemographic characteristics perceived automation as a threat to their jobs. Table 3 reports the interactions between the variables age and race in column 1, age and education in column 2, age and income in column 3, race and education in column 4, race and income in column 5, and race and education in column 6. As we see in column 1, black or African Americans who are between 35 years and 49 years old or residents in other racial groups who are 65 years or older were less likely to perceive automation as a threat to their jobs. Likewise, as the results indicate in column 3, residents who are 65 years or older and whose annual household income is $25,000 or less or between $120,000 and $250,000 were less likely to perceive automation as a threat to their jobs. Blacks or African Americans whose annual household income is $25,000 or less were less likely to perceive automation as a threat to their jobs. Nevertheless, blacks or African Americans whose annual household income is between $120,000 and $250,000 were more likely to perceive automation as a threat to their job (column 5). Likewise, residents with a graduate or a professional degree whose annual household income is $25,000 or less were more likely to perceive automation as a threat to their jobs (column 6). However, the interactions between the variables age and education (in column 2) or race and education (in column 5) are not significant.
### Table 3
Who perceived automation as a threat to their jobs in metro Atlanta – exploring interaction effects.

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------|-----|-----|-----|-----|-----|-----|
| **Age group (base: 18-34 years)** | | | | | | |
| 35-49 years | 1.1503** | 0.0839 | 0.6461 | 0.3395 | 0.2889 | 0.2509 |
| | (0.5523) | (0.7313) | (0.5911) | (0.3785) | (0.3725) | (0.3726) |
| 50-64 years | 0.9331 | 1.1353** | 1.1640** | 0.9952*** | 0.9744*** | 0.9141** |
| | (0.3835) | (0.6795) | (0.5300) | (0.3616) | (0.3625) | (0.3712) |
| 65+ years | 1.7892** | -0.4372 | 1.7325** | 1.0159 | 0.9835 | 0.9670 |
| | (0.7799) | (1.1862) | (0.8170) | (0.6310) | (0.6550) | (0.6415) |
| **Race/ethnicity (base: White)** | | | | | | |
| Black or African American | 1.2313** | 0.7940** | 0.9129*** | 0.8768 | 0.8639* | 0.8859*** |
| | (0.5940) | (0.3193) | (0.3206) | (0.5570) | (0.4519) | (0.3226) |
| Other race | 1.3276* | 0.5812 | 0.7039 | 0.5853 | 1.0929 | 0.6526 |
| | (0.7903) | (0.5070) | (0.5077) | (0.8757) | (0.8800) | (0.4880) |
| Hispanic or Latino | -1.2773** | -1.2354** | -1.2729** | -1.2798** | -1.1463* | -1.2710** |
| | (0.5547) | (0.5769) | (0.5504) | (0.6041) | (0.5927) | (0.5700) |
| **Education (base: College degree)** | | | | | | |
| HS grad or less | -0.8117* | -1.2012 | -0.8838* | -0.5387 | -0.9445** | -0.9631 |
| | (0.4618) | (0.8422) | (0.4736) | (0.5809) | (0.4544) | (0.7944) |
| Some college | 0.4694 | 0.5258 | 0.4674 | 0.4927 | 0.5311 | 0.4026 |
| | (0.3498) | (0.6403) | (0.3346) | (0.4776) | (0.3392) | (0.5201) |
| Grad/Professional degree | -0.9102** | -0.8574 | -0.9486** | -0.8461 | -0.9774** | -1.6426*** |
| | (0.3746) | (0.4811) | (0.3853) | (0.5783) | (0.3934) | (0.6148) |
| **Income (base: $60 K – $120 K)** | | | | | | |
| < $25 K | 2.2047*** | 2.2496*** | 2.3431*** | 2.2395*** | 3.1073*** | 1.0616 |
| | (0.4875) | (0.5058) | (0.8037) | (0.5966) | (0.5948) | (0.6859) |
| $25 K – $60 K | 0.2202 | 0.1878 | 0.5632 | 0.1991 | 0.2334 | 0.1070 |
| | (0.4116) | (0.4019) | (0.6148) | (0.4122) | (0.6275) | (0.6682) |
| $120 K – $250 K | -0.4738 | -0.5116 | -0.0561 | -0.5000 | -0.8801* | -0.4535 |
| | (0.3567) | (0.3538) | (0.8154) | (0.3340) | (0.5280) | (0.5707) |
| $250 K+ | -2.3007*** | -2.3638*** | -2.0931 | -2.4049*** | -2.7100*** | 2.3127 |
| | (0.7662) | (0.7987) | (1.4617) | (1.0549) | (1.8043) | |
| **Years of tenure (base: 10 years or less)** | | | | | | |
| 11-20 years | 0.2731 | 0.3470 | 0.4272 | 0.3478 | 0.2624 | 0.4528 |
| | (0.3939) | (0.3949) | (0.3880) | (0.3846) | (0.3813) | (0.3855) |
| 21-30 years | 0.2177 | 0.2594 | 0.2574 | 0.2523 | 0.1139 | 0.3399 |
| | (0.3915) | (0.3949) | (0.3911) | (0.3859) | (0.3966) | (0.3846) |
| 30 years+ | -0.6659 | -0.7025 | -0.5094 | -0.6494 | -0.6306 | -0.5775 |
| | (0.4711) | (0.4746) | (0.4551) | (0.4595) | (0.4608) | (0.4655) |
| **Home owner** | -0.3197 | -0.3067 | -0.2742 | -0.2195 | -0.2613 | -0.3157 |
| | (0.3438) | (0.3370) | (0.3315) | (0.3381) | (0.3385) | (0.3412) |
| **South of I-20** | 0.2504 | 0.3337 | 0.3230 | 0.3290 | 0.2583 | 0.4137 |
| | (0.5659) | (0.5402) | (0.5534) | (0.5443) | (0.5482) | (0.5551) |

**Interaction effects (age and race)**

- 35-49 years × Black or African American | -1.3236* | (0.7231) |
- 35-49 × Other race | -1.8569 | (1.1554) |
- 50-64 × Black or African American | 0.2929 | (0.7814) |
- 50-64 × Other race | -0.3096 | (1.1936) |
- 65+ × Other race | -2.3692* | (1.3635) |

**Interaction effects (age and education)**

- 35-49 × H.S. grad or less | 0.6184 | (1.1450) |
- 35-49 × Some college | 0.0980 | (0.8728) |
- 35-49 × Grad/Professional degree | 0.6924 | (1.0578) |
- 50-64 × H.S. grad or less | 0.6375 | (1.1178) |
- 50-64 × Some college | -0.2235 | (0.7815) |

(continued on next page)
Table 3 (continued)

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------|-----|-----|-----|-----|-----|-----|
| 50-64 × Grad/Professional degree | -1.7983 | (1.2243) | | | | |
| 65+ × H.S. grad or less | 1.3289 | (1.7077) | | | | |
| 65+ × Some college | 1.9563 | (1.5418) | | | | |
| 65+ × Grad/Professional degree | 2.5186 | (1.7088) | | | | |

Interaction effects (age and income)

| 35-49 × < $25 K | 0.5857 | (1.0614) | | | | |
| 35-49 × $25 K – $60 K | -0.8608 | (0.8290) | | | | |
| 35-49 × $120 K – $250 K | -0.7647 | (1.0456) | | | | |
| 35-49 × $250 K + | 0.0000 | (0.000) | | | | |
| 50-64 × < $25 K | -1.0861 | (1.2978) | | | | |
| 50-64 × $25 K – $60 K | -0.2376 | (0.8022) | | | | |
| 50-64 × $120 K – $250 K | -0.2515 | (0.9888) | | | | |
| 50-64 × $250 K + | -1.3001 | (1.8475) | | | | |
| 65+ × < $25 K | -5.3987*** | (1.6290) | | | | |
| 65+ × $25 K – $60 K | -0.0332 | (1.2953) | | | | |
| 65+ × $120 K – $250 K | 1.1654* | (0.7076) | | | | |
| 65+ × $250 K + | 1.5577 | (2.0920) | | | | |

Interaction effects (race and education)

| Black × H.S. grad or less | -0.5625 | (0.9166) | | | | |
| Black × Some college | 0.0915 | (0.6711) | | | | |
| Black × Grad/Professional degree | -0.0370 | (0.8608) | | | | |
| Other race × H.S. grad or less | 0.1821 | (1.5954) | | | | |
| Other race × Some college | 0.0879 | (1.1795) | | | | |
| Other race × Grad/Professional degree | -0.3323 | (1.1442) | | | | |

Interaction effects (race and income)

| Black × < $25 K | -1.8663*** | (0.9170) | | | | |
| Black × $25 K – $60 K | -0.0532 | (0.8532) | | | | |
| Black × $120 K – $250 K | 1.1654* | (0.7076) | | | | |
| Other race × < $25 K | -2.0072 | (1.3039) | | | | |
| Other race × $25 K – $60 K | -0.2069 | (1.2547) | | | | |
| Other race × $120 K – $250 K | -1.5125 | (1.3095) | | | | |
| Other race × $250 K + | 2.3737 | (1.9482) | | | | |

Interaction effects (education and income)

| HS grad or less × < $25 K | 1.7256 | (1.3009) | | | | |
| HS grad or less × $25 K – $60 K | -0.6147 | (1.1618) | | | | |
| HS grad or less × $120 K – $250 K | 0.7736 | (1.1522) | | | | |

(continued on next page)
Additionally, many such workers might not have updated their skills included in university or college curricula some 15 years ago, where college or university curricula were utterly different.

Population who are 45 years or older had a bachelor degree or more in metro Atlanta [46]. Further, those who had a bachelor’s degree or more went to colleges or universities some 20–30 years ago, where college or university curricula were utterly different from those of today. For instance, computer applications, information technology, artificial intelligence, and machine learning were not included in university or college curricula some 15–20 years ago. Additionally, many such workers might not have updated their skills since their degree attainment, despite the societal changes in skills in demand. Also, the propensity or motivation to learn new skills slows with getting older. Hence, automation as a threat perceived by relatively older residents in metro Atlanta, in general, is legitimate.

Automation as a threat perceived by the black or African American residents in metro Atlanta could be as a result of their sociodemographic characteristics (less educated, work in automation prone occupations, and typically in supporting roles). Nearly 29% of blacks or African Americans who are 18 years or older had a bachelor’s degree, compared to almost 43% of whites who are 18 years or older in metro Atlanta with a bachelor’s degree [46]. Looking at only those who are employed, 33% of blacks or African Americans have a bachelor’s degree or more, compared to 54% of whites who have a bachelor’s degree or more in metro Atlanta. Further, in the occupation families where automation risk is deemed to be 50% or more in the coming decades in metro Atlanta, 43% of workers are blacks or African Americans compared to 54% of whites who have a bachelor degree or more.

Automation as a threat perceived by blacks or African Americans is nearly $69,000, compared to almost $32,000 for those who are in directive roles, and the median income in 2016 of workers in directive roles rather than in fast-growing, high-paying directive roles, making African American employment is in slow-growing, low-paying support roles. However, for blacks or African Americans, 44% have a directive role, and 56% have a support role. Job growth is estimated to be 9% for directive roles, compared to 1.5% for support roles, and the median income in 2016 of workers in directive roles is nearly $69,000, compared to almost $32,000 for those who are in support roles [2]. Hence, automation as a threat perceived by blacks or African Americans in metro Atlanta, in general, is also real.

Low-income residents are another sociodemographic group who

5. Discussions

Relatively older residents, blacks or African Americans, and low-income residents in metro Atlanta perceived automation as a threat to their jobs, a finding consistent with McClure (2017), who reported that non-white ethnic minorities in the U.S. have disproportionately higher fears of continual encroachment of technology into modern life [4]. These are also the sociodemographic groups, who are deemed more vulnerable to automation in general [1,2,7]. Our finding is also consistent with the most recent Pew Survey, where 55% of U.S. adults who were 50 years or older perceived that job automation would hurt workers in the future [43]. Automation as a threat perceived by older residents could be because of a skills gap – the gap between their skills and the skills currently in demand or trending in metro Atlanta. A most recent LinkedIn (2019) workforce report indicates that oral communication, business management, leadership, development tools, time management, people management, digital literacy, social media, data storage technologies, and data science are the top skills shortages in the metro Atlanta [44]. According to WorkSource Atlanta (2019), business services; construction; transportation, distribution and logistics; health sciences; hospitality and tourism; information technology; and public services are the high demand occupations in metro Atlanta [45]. For a complete list of the high demand occupations in metro Atlanta, please visit the WorkSource Atlanta website - http://www.worksourceatlanta.org/job-trends/high-demand-occupations/.

Further, a relatively larger percentage of these older residents do not have a bachelor’s degree or more, as compared to the educational attainment of other generations in metro Atlanta. According to the 2013–2017 American Community Survey (2018), nearly 35% of the population who are 45 years or older had a bachelor’s degree or more compared to 41% of the population of the 35–44 years cohort, having a bachelor’s degree or more in metro Atlanta [46]. Further, those who had a bachelor’s degree or more went to colleges or universities some 20–30 years ago, where college or university curricula were utterly different from those of today. For instance, computer applications, information technology, artificial intelligence, and machine learning were not included in university or college curricula some 15–20 years ago. Additionally, many such workers might not have updated their skills
perceived automation as a threat to their jobs in metro Atlanta. These low-income residents, in general, work in the jobs or the occupation families where automation risk is relatively higher in metro Atlanta, and wages in these occupations are comparatively lower. For instance, the average annual wage in the food preparation and serving related occupations is nearly $22,000 in 2018; $33,000 in the farming, fishing, and forestry occupations; $37,000 in the production occupations; $40,000 in transportation and material moving occupations; and $46,000 in the construction and extraction occupations. These levels compare to an overall (all occupations) average annual wage of nearly $53,000 a year in metro Atlanta [13]. The finding, hence, supports the conventional belief that automation risk to be higher in jobs or occupation families that pay less, and automation as a threat perceived by these low-income residents in metro Atlanta, in general, is accurate. In contrast, per expectation, highly educated or high-income residents do not perceive automation as a threat to their jobs in metro Atlanta, perhaps because of their better skills or higher incomes. Hence, our finding supports the conventional wisdom that having a university or a professional degree can lower the automation risk substantially [3,6,48].

Contrary to the expectation, Hispanic or Latino and less educated (high school or less educated) residents do not perceive automation as a threat to their jobs despite a large proportion of Hispanic or Latino or less-educated workers working in automation-prone jobs or occupation families in metro Atlanta. For instance, nearly 43% of workers in the farming, fishing, and forestry occupation are Hispanic or Latino, compared to 21% of whites and 22% of black or African American workers in the same occupation family. Likewise, 52% of workers in the construction and extraction occupation are Hispanic or Latino, compared to nearly 28% of white and 17% of black or African American workers in that same occupation family [47]. Almost 28% of the workforce in the 10-county metro Atlanta region are high school graduates or less, and 48% of the workforce that is employed in occupation families where automation risk is deemed to be 50% or more are high school graduates or less educated in 2018. However, there is variance across occupation families, with nearly 75% of workers in the construction and extraction; 65% in farming, fishing, and forestry; 61% in production; 54% in food preparation and serving related; and 53% in transportation and material moving occupations are high school graduates or less educated in 2018 [47]. Older residents in other racial groups, older and low-income residents (65+ and with household income below $25,000) or low-income black or African American residents (with income below $25,000) do not perceive automation as a threat to their jobs, despite being deemed more vulnerable to automation because of their socioeconomic and demographic characteristics.

Although Hispanics or Latinos and less educated residents are identified more vulnerable to automation, these sociodemographic groups do not perceive automation as a threat to their jobs in metro Atlanta. Hence, these sociodemographic groups are more likely to be unemployed because of the automation-induced disruption in the labor market in the near future. As such, agencies working in workforce development such as the Atlanta Regional Workforce Development Board should target outreach efforts to these sociodemographic groups and educate them about the potential disruption in the labor market due to automation. At the regional level, the Atlanta Regional Workforce Development Board pursues a number of initiatives to lower the automation-induced disruption in labor market in the metro Atlanta area. The board works to increase metro Atlanta’s competitiveness in the global economy by providing local employment with a robust workforce and labor market services. The board also seeks to provide the highest-level opportunities for the Atlanta region and also ensure that metro Atlantans have access to all labor market information and quality training and employment services to achieve their career goals. The board offers a number of programs and services to residents, ranging from career assessment testing to job readiness training to job search training to assistance in locating training providers in the metro Atlanta region [49].

In addition to providing these general services, the Regional Workforce Development Board also may need to design policies and programs specifically for these sociodemographic groups who do not perceive automation as a threat to their jobs despite being deemed more vulnerable to automation in metro Atlanta (e.g., Hispanic or Latino residents, less-educated residents, older residents in other racial groups, older and low-income residents, and low-income black or African American residents). The form of the training should emphasize target groups’ ability to accomplish it, as well as provide a means of educating them about the potential outcomes of automation-induced disruption. To mitigate the automation-induced disruption, it is crucial that metro Atlanta and the state of Georgia should embrace the growth of the “opportunity jobs” – those jobs having a lower probability of automation, but pay a living wage, and are projected to grow in the future – through various incentives in their economic development plans (e.g., tax incentives). According to Accenture (2019), there are nearly 612 jobs in metro Atlanta, out of which 259 jobs are automation resilience. Of all automation resilient jobs, 246 jobs provide a living wage, and 107 jobs out of all resilient and well-paid jobs are projected to grow by at least 6% by 2026 and have at least 590,000 positions. However, 65% of all opportunity jobs have high barriers to entry, making transitions difficult. Also, 84% of opportunity jobs have high levels of augmentation potential [27]. This again stresses the need to acquire new skills as workers would need to interact with technologies more often with augmentation [50]. Skill enhancement through training is, hence, crucial to absorb displaced workers in the economy.

The political-economic literature also discusses regulating the introduction of robotics and artificial intelligence (A.I.) by using fiscal measures such as taxes. For instance, Bill Gates, the co-founder of the Microsoft Corporation, proposes a robot tax to discourage companies using robotics and A.I., which displace human workers, and also to help out those that got unemployed due to automation, computerization, and robotization. However, the opponents of the robot tax argue that robot tax may drive capital abroad and further increase unemployment rates unless it is implemented internationally [51]. Since automation is more likely to displace less-educated or low-income workers, policies such as universal basic income may help workers buffer against poverty, and guarantee access to resources to require maintaining their living conditions [51,52]. Also, policies should focus on narrowing down the skill gaps to minimize the technology-induced disruption in the labor market. The education system should focus on developing a labor force where workers, and computers, robots, and A.I. are complements rather than substitutes for each other [51].

6. Conclusions

Previous studies have identified that ethnic minorities, less-educated or less-skilled workers, or low-income workers are, in general, more vulnerable to automation than their counterparts [1,3,6,7]. Consistent with their findings, we find that relatively older residents, black or African Americans, and low-income residents did perceive automation as a threat to their jobs in metro Atlanta. However, Hispanic or Latino residents, less-educated residents, low-income black or African American residents, and low-income older residents did not perceive automation as a threat to their jobs despite being deemed vulnerable to automation because of their sociodemographic characteristics. Hence, automation can further increase unemployment rates among Hispanics or Latinos and less-educated residents in metro Atlanta. As we discussed earlier, 48% of the workforce in the occupation families where automation risk is estimated to 50% or more have a high school degree or less. Likewise, 17% of workers are Hispanic or Latino in the occupation families, where automation risk is deemed to be 50% or more in the coming decades [47]. The COVID-19 pandemic could further accelerate and expand the process of job automation because of the growing concerns of maintaining social distancing, and this process is more likely to make thousands of low-skilled or low-wage workers unemployed. In this regard, in
addition to providing short-term supports (e.g. unemployment insurance) to those displaced workers, policies narrowing down skills gaps help these workers finding jobs in other sectors not hard hit by COVID-19 related economic shocks. Atlanta Regional Workforce Development Board should tailor or modify existing policies and programs to accommodate the training needs of these residents to mitigate potential automation-induced labor market disruption. The region needs to focus on the growth of the “opportunity jobs,” which are automation resilience, pay living wages, and are projected to grow in the future, rather than mere expanding automation prone, low-wage jobs. Also, the region needs to focus on narrowing down the skill gaps through reforming the education system, in general.

Credit author statement

Ramesh Ghimire: reviewed the literature, developed the theoretical model, analyzed the data, and discussed the findings. Jim Skinner: developed the survey instruments, managed the survey, and helped develop the introduction section. Mike Carnathan: developed the survey instruments and helped develop the introduction section.

Acknowledgements

This article benefited from very helpful comments provided by three anonymous reviewers and the editor-in-chief. The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Atlanta Regional Commission.

References

[1] M. Muro, R. Maxim, J. Whiton, Automation and Artificial Intelligence: How Machines Are Affecting People and Places, Metropolitan Policy Program at Brookings, 2019. https://www.brookings.edu/wp-content/uploads/2019/01/2019-01-BrookingsMetro-Automation-Al-Report_Muro-Maxim-Whiton-FINAL-ver-sion.pdf.

[2] D. Baboolall, D. Finder, S. Stewart, J. Wright, Automation and the Future of the African American Worker, 2018. https://www.mckinsey.com/featured-insigh-ts/future-of-work/automation-and-the-future-of-the-african-american-worker#.

[3] C.B. Frey, M.A. Osborne, The future of employment: how susceptible are jobs to computerization? Technol. Forecast. Soc. Change 114 (2017) 254–286.

[4] P.K. McClure, ‘You’re fired, says the robot: the rise of automation in the workplace, technophobes, and fears of unemployment, Soc. Sci. Comput. Rev. 36 (2) (2018) 139–156.

[5] A. D. Acemoglu, Technical change, inequality, and the labor market, J. Econ. Lit. 50 (2002) 72–77.

[6] J. Chen, Automation Expected to Disproportionately Affect the Less Educated: Hispanics, African-Americans, and Young Particularly at Risk, 2017. https://www.neshuphub.com/index.php?lang=en/2017/06/26/automation-expected-to-disproportionately-affect-the-less-educated/.

[7] Oxford Economics, How Robots Change the World: what Automation Really Means for Jobs and Productivity, 2019. https://www.oxfordeconomics.com/recent-reports/how-robots-change-the-world/.

[8] The Economist, Automation and Anxiety, 2016. https://www.economist.com/special-report/2016/06/23/automation-and-anxiety.

[9] D.H. Autor, Why are there still so many jobs? The history and future of workplace automation, J. Econ. Perspect. 29 (3) (2015) 5–20.

[10] U.S. Council of Economic Advisers, Annual Report, 2016. Chapter 5, https://obama-whitehouse.archives.gov/sites/default/files/docs/ERP2016_Chapter_5.pdf.

[11] Metro Atlanta Chamber, Trees Aren’t the Only Things Growing Here, 2019. https://www.metroatlachamber.com/resources/most-popular/fortune-500-for-tune-1000-in-metro-atlanta.

[12] Wallsethurb, 2019’s Fastest-Growing Cities in America, 2019. https://wallsethurb.com/edu/fastest-growing-cities/7010/.

[13] CHMURA JobsEQ, JobsEQ, 2019, http://www.chmuraecon.com/jobseq.

[14] S.R. Khan, Reinventing capitalism to address automation: sharing work to secure the minimum welfare measures? IZA World of Labor 128 (2019) https://doi.org/10.15158/IZA-LEK/vol99_Dom.pdf.

[15] S. Rice, S.R. Winter, Do gender and age affect willingness to ride in driverless vehicles: if so, then why? Technol. Soc. 59 (2019) 101–145.

[16] Atlanta Regional Commission, Metro Atlanta Speaks Survey 2019, Atlanta Regional Commission, Atlanta, GA, 2019. https://atlantaregional.org/atlanta-region/area-data-resources/metro-atlanta-speaks-survey-report/.

[17] R. Ghimire, J. Skinner, The Relationship between length of community tenure and residents’ volunteering at community events: results from the Metro Atlanta Speaks survey, Journal of Rural Social Sciences 34 (2) (2019).

[18] R. Ghimire, J. Skinner, Perceived reasons for paying more for housing in metro Atlanta: results from the 2018 Metro Atlanta Speaks survey, J. Urban Aff., 2020, https://doi.org/10.1080/10930097.2020.1814154 (in press).

[19] R. Ghimire, Homeownership and Volunteering: Results from the 2019 Metro Atlanta Speaks Survey, Atlanta Regional Commission, Atlanta, GA, 2020.

[20] Brookings Institution Center on Urban, Metropolitan Policy. Moving beyond the Challenge for Metropolitan Atlanta, 2000. https://www.brookings.edu/wp-content/uploads/2016/06/atlanta.pdf.

[21] J.M. Wooldridge, Econometric Analysis of Cross Section and Panel Data, MIT press, 2010.

[22] R. B. Williams, Logistic Regression, Part II: the Logistic Regression Model (LRM) – Interpreting Parameters, 2015. https://www3.nd.edu/~rwil/lm/stats2b.pdf.

[23] D. Pfeffermann, The use of sampling weights for survey data analysis, Stat. Methods Med. Res. 5 (3) (1996) 239–261.

[24] D.N. Goswati, Basic Econometrics, Tata McGraw-Hill Education, New Delhi, 2012.

[25] A.W. Geiger, How Americans See Automation and the Workplace in 7 Charts, 2019. https://www.pewresearch.org/fact-tank/2019/04/08/how-americans-see-automation-and-the-workplace-in-7-charts/.

[26] LinkedIn. Workforce Report September 2019, Atlanta, 2019. https://www.linkedin.com/jobs/workforce-report-september-2019-atlanta-ga.

[27] WorkSource Atlanta, High Demand Occupations, 2019. http://www.worksourceatlanta.org/job-trends/high-demand-occupations/.

[28] U.S. Census Bureau, American Community Survey 5-year Estimates, 2019. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_5YR_S1501&prodType=table, 2013-2017.

[29] Burning Glass, Labor Insight: Labor Market Data at Your Fingertips to Support Critical Decisions, 2017. https://www.burning-glass.com/products/labor-insight/.

[30] M. Whitehouse, M. Rojanasakul, Find Out if Your Job Will Be Automated, 2017. https://www.bloomberg.com/graphics/2017-job-risk/.

[31] Atlanta Regional Commission, Atlanta regional workforce development board, http://atlantaregional.org/workforce-economy/boards-and-committees/atlanta-regio-nal-workforce-development-board/.

[32] L.G. Hammershøi, The division of labor between human and machine and its educational implications, Technol. Soc. 59 (2019) 101–144.

[33] B. Vermeulen, J. Kessels, A. Pyka, P.P. Saviotti, The impact of automation on employment: just the usual structural change? Sustainability 10 (5) (2018) 1661.

[34] U. Colombino, Is unconditional basic income a viable alternative to other social welfare measures? IZA World of Labor 128 (2019) https://doi.org/10.15185/iza.128.v2.