AN ESRI
WHITE PAPER

JUNE 2020

Methodology Statement: 2020/2025 Esri Updated Demographics

380 New York Street
Redlands, California 92373-8100 USA
909 793 2853
info@esri.com
esri.com

esri | THE SCIENCE OF WHERE®

Table of Contents

Data Vintage and Variables 4

COVID-19 Adjustments 6

Summary Totals 7

5-Year Projections 8

Population and Household Characteristics 9

Housing Data 11

Labor Force Data 13

Household Income 14

Household Income by Age of Householder 16

Disposable Income 16

Net Worth 17

2020 Geography 17

Methodology Statement: 2020/2025 Esri Updated Demographics

Data Vintage and Variables

Esri presents the 2020/2025 demographic forecasts. Esri Updated Demographics are point estimates representing July 1 of the current and forecast years. The following table summarizes the updated demographic variables. Also included are select averages, medians, aggregates, and per capita values.

	Updated Demographics	2020	2025
Totals	Total Population	✓	✓
	Daytime Population	✓	
	Time Series	✓	
	Households	✓	✓
	Household Population	✓	✓
	Family Population	✓	✓
	Family Households	✓	✓
	Group Quarters Population	✓	✓
	Housing Units	✓	✓
	Owner-Occupied Housing Units	✓	✓
	Renter-Occupied Housing Units	✓	✓
	Vacant Housing Units	✓	✓
Population Characteristics	Population by Five-Year Age and Sex	✓	✓
	Population by Single-Year Age and Sex	✓	✓
	Population by Age, Sex, and Race	✓	✓
	Population by Age, Sex, and Hispanic Origin	✓	✓
	Employed & Unemployed Population 16+	✓	
	Employed & Unemployed Population 16+ by Age Group	✓	
	Employed Population 16+ by Industry	✓	
	Employed Population 16+ by Occupation	✓	
	Population 25+ by Educational Attainment	✓	
	Population 15+ by Marital Status	✓	
	Population by Generation	✓	✓
Housing Characteristics	Households by Income	✓	✓
	Households by Income and Age of Householder	✓	✓
	Households by Disposable Income	✓	
	Households by Disposable Income and Age of Householder	✓	
	Households by Net Worth	✓	
	Households by Net Worth and Age of Householder	✓	
	Owner-Occupied Housing Units by Home Value	✓	✓
Indexes and Measures	Diversity Index	✓	✓
	Housing Affordability Index	✓	
	Percent of Income for Mortgage	✓	
	Wealth Index	✓	
	Child Dependency Ratio	✓	✓
	Age Dependency Ratio	✓	✓
	Senior Dependency Ratio	✓	✓

COVID-19 Adjustments

Unprecedented. Extraordinary. Unparalleled. These are common and apt refrains describing the personal and financial toll caused by the ongoing coronavirus disease 2019 (COVID-19) global pandemic. In the near term, the economic impact is prominent and measurable. Over the longer horizon, this pandemic will undoubtedly leave its mark on socioeconomic and demographic trends.

Prior to the pandemic, the US economy entered its 11th year of expansion, operating near full capacity with unemployment hovering at historic lows. This was the longest expansion on record, eclipsing the 120 months of consecutive growth from March 1991 to March 2001. The pre-COVID expansion began in July 2009, and by 2020, many were expecting a downturn as part of the historical ebb and flow of the economy. As COVID-19 captured the world's attention, it became clear that this year would indeed be the start of a period of economic uncertainty.

By mid-March 2020, it was clear that the US would be dealing with a major health and economic crisis. Federal, state, and local governments scrambled to implement the nation's largest ever quarantine effort. Businesses were shuttered, travel restricted, and shelter in place rules were issued. The response was like flipping off an economic light switch across many industries. US jobless claims skyrocketed quickly, overwhelming unemployment insurance programs. As of late May 2020, there are concerns that unemployment may reach depression era levels of 20 to 25 percent. Wealth evaporated as financial markets reacted. It took a matter of days to send markets into a historic economic tailspin. It may take years to fully recover.

The demographers, economists, statisticians, and geographers at Esri who are responsible for developing US Updated Demographics were tasked with making "eleventh hour" adjustments to select current-year estimates and five-year projections. The challenge was making the necessary adjustments to reflect a revised socioeconomic profile while the federal, state, and local response to the pandemic was ongoing and new events were unfolding daily. Given the speed and severity of the crisis, standard data inputs were not available for modeling. Weekly state-level unemployment insurance claim data was coupled with data and analysis from academic institutions and think tanks to help guide the teams' decades of modeling experience. Efforts were made to be conservative while trying to best forecast the "new normal" of our society as of July 1, 2020.

The following characteristics received special COVID-19 adjustments for the June 2020 release of Esri's US Updated Demographics:

- 2020 Households by Net Worth
- 2020 Households by Net Worth and Age of Householder
- 2020 Housing Affordability Index
- 2020 Percent of Income for Mortgage
- 2020 Wealth Index
- 2020 Employed & Unemployed Population 16+
- 2020 Employed & Unemployed Population 16+ by Age Group
- 2020 Employed Population 16+ by Industry
- 2020 Employed Population 16+ by Occupation
- 2020 & 2025 Owner-Occupied Housing Units by Home Value
- 2025 Households by Income
- 2025 Households by Income and Age of Householder
- 2025 Per Capita Income

- 2025 Owner-Occupied Housing Units
- 2025 Renter-Occupied Housing Units

COVID-19 adjustments were focused on socioeconomic characteristics as these variables are prone to change abruptly in a global pandemic. Demographic trends such as births, deaths, and migration are likely to be affected as well but take longer to transpire. Future releases of Updated Demographics will include a broader view of the COVID-19 impact. Where applicable, more information can be found on 2020/2025 adjustments in the relevant sections below.

Summary Totals

Forecasting change in the size and distribution of the household population begins at the county level with several sources of data. Esri incorporates a full-time series of intercensal and vintage-based county estimates from the US Census Bureau. Because testing has revealed improvement in accuracy by using a variety of sources to track county population trends, Esri also employs a time series of county-to-county migration data from the Internal Revenue Service, building permits and housing starts, plus residential postal delivery counts. Finally, local data sources that tested well against Census 2010 are reviewed. The end result balances the measures of growth or decline from a variety of data series.

Measuring change in population or households at the county level is facilitated by the array of data reported for counties. Unfortunately, there is no current data reported specifically for block groups. Past trends can be calculated from previous census counts; the American Community Survey (ACS) provides five-year averages. However, these sources are not recent. To measure current population change by block group, Esri models the change in households from multiple sources: Experian; the US Postal Service (USPS); Metrostudy, a Hanley Wood company; and Axiometrics, in addition to several ancillary sources.

The US Postal Service publishes monthly counts of residential deliveries for every US postal carrier route. This represents the most comprehensive and current information available for small, subcounty geographic areas. Carrier routes are a fluid geographic construct that is redefined continuously to incorporate real changes in the housing inventory and occupancy plus administrative changes in staffing and budgets of local post offices.

Converting delivery statistics from postal carrier routes to census block groups is a complex challenge. Carrier routes are defined to deliver the mail, while block groups are constructed to collect and report census data. Comparing two different areas that are defined for wholly different purposes provides one significant conversion issue. Carrier routes commonly overlap multiple block groups. In many cases, a carrier route encompasses disjointed areas that can be distant from each other, but block groups are rarely divided into multiple polygons. These overlaps require an effective method of allocating the postal delivery counts across multiple block groups.

Esri has developed a technique to link a carrier route to the correct block group(s)—using the actual locations of mail deliveries. Its proprietary Address Based Allocation (ABA) methodology was developed in 2005 to solve the complex challenge of converting delivery counts from carrier routes to block groups. This allocation method assigns carrier routes using household addresses that are geocoded at the block level to serve as the foundation for the conversion. The approach is unbounded by

geographic borders or arbitrary assumptions about the distribution of households or postal deliveries. ABA results have been tested extensively against Census 2010 counts, including an independent evaluation that involved data from four other vendors. This test confirmed the accuracy of Esri's ABA allocation method.[1]

For over a decade, Esri has licensed data from Metrostudy to track new residential construction in the top US housing markets. This database identifies the location and characteristics of individual construction projects, including total units planned, under construction, and closed by type of housing. This data is especially critical in tracking growth in previously unpopulated areas. Beginning with the 2016 updates, Esri has utilized an additional database from Metrostudy that more than doubles Esri's geographic coverage and the number of units planned and completed. The addition of this database gives the household and housing unit update a finer level of granularity and insight into smaller housing markets across the nation.

Axiometrics housing data is incorporated to capture the growing multifamily rental market. Like Metrostudy, which covers new residential-owned dwellings like single family homes and condominiums, Axiometrics collects and maintains data on planned, new, and existing rental properties of multifamily and student apartments, nationwide. This data source provides a wealth of property-level characteristics, such as the total number of units or beds, building type, number of stories, and occupancy, as well as asking rent. Axiometrics' inventory of rental properties expanded due to a corporate merger. This contributed to a near 30 percent increase in rental properties incorporated in our models this year.

The best techniques are derived from a combination of models and data sources. Discrepant trends are checked extensively against independent sources and premium imagery data from Esri's ArcGIS Living Atlas of the World. Finally, totals for block groups are controlled to the county totals. Despite the appeal of microforecasting, there is simply more information available to track population change by county than by household. Ignoring the advantage of county-level data would be throwing away information.

5-Year Projections

Projections are necessarily derived from current events and past trends. The past and present are known; the future must be extrapolated from this knowledge base. Even though projections represent the unknown, they are not uninformed. Guidelines for the development of projections also inform the use of those projections.

- The recent past provides a reasonable clue to the course of future events, especially if that information is tempered with a historical perspective.
- A stable rate of growth is easier to anticipate than rapid growth or decline.
- The damaging effects of natural disasters cannot be anticipated. Esri makes every effort to assess the impact of sudden, catastrophic events like strong storms, flooding, or wildfires.

[1] esri.com/~/media/Files/Pdfs/library/brochures/pdfs/vendor-accuracy-study.pdf

- The risk inherent in forecasting is inversely related to the size of an area: the smaller the area, the greater the risk.

- The risk increases with the length of the projection interval. Any deviation of the projected trends from actual events is amplified over time.

Esri revises its forecasts annually to draw on the latest data. Future construction projects, as well as developments currently under construction, give Esri a unique view of the future landscape. Projections can be enhanced with personal knowledge of an area to provide the qualitative, anecdotal detail that is not captured in a national database. It is incumbent on the data user and the producers to incorporate as much information as possible when assessing local trends, especially for areas that are subject to "boom-bust" cycles or natural disasters.

Population and Household Characteristics

Esri incorporates a variety of data sources to update small areas like block groups, beginning with the latest base, then adding a mixture of administrative records and private sources to capture change to the base. Shifting the base every year to the latest release of ACS data incorporates real change with sampling error. To establish a more stable base, Esri has built estimate bases for key variables like income, labor force, and home value. The estimate bases combine the best data from ACS with other sources and enable better measures of change than are possible with ACS data alone. Periodic changes to the estimate bases are necessary to collect current change. Base changes impact comparability of the annual data but provide more reliable estimates. Demographic updates must incorporate both traditional and new data sources to remain current.

The population by age and sex is projected via a cohort survival model that separately calculates the components of population change by age and sex. Applying survival rates specific to the cohort carries a 2015 population base forward. Changes in the population by age and sex diverge at the household level. For example, an area that is losing population can age more rapidly with the loss of population in prime migrant ages, 20–34 years—unless there is a college nearby. Neighborhoods near colleges sustain high turnover from student populations but retain their youthful age distributions.

To capture these variations, Esri's model first separates the group quarters' population from the household population and, second, keys the calculations to the size and characteristics of the population. This stratification identifies several different patterns of change by age and sex that can be applied in a cohort survival model.

The changing profile of the US population requires measuring population change by race and Hispanic origin. The American identity is shaped by diversity. Tracking the changing patterns of race and ethnicity provides a current portrait of our society. Historical trends in race and ethnicity combined with the most current data sources by race and Hispanic origin, including population estimates by county and state from the Census Bureau and survey data from the ACS, are analyzed to establish county population by race and Hispanic origin. Forecasts by block group combine local changes in the distributions by race and projected change for counties. The last step controls block group distributions to county totals by race and Hispanic origin.

The changing face of our nation is evident in Esri's Diversity Index, which summarizes racial and ethnic diversity in an area. Esri's definition of diversity is two-dimensional and combines racial diversity with ethnic diversity. This measure shows the likelihood that two persons, chosen at random from the same area, belong to different races or ethnic groups. In theory, the index ranges from 0 (no diversity) to 100 (complete diversity). An area's diversity index tends toward 100 when the population is more evenly divided across race and ethnic groups. If an area's entire population is divided evenly into two race groups and one ethnic group, then the diversity index equals 50. As more race groups are evenly represented in the population, the diversity index increases. Race and Hispanic origin data is reported by the Census Bureau and other agencies as grouped summary data; therefore, in practice, the diversity index will not reach the maximum value of 100. Nationally, Esri's Diversity Index has risen from 60.6 in 2010 to 65.1 in 2020, with a forecast to 67.3 in five years.

Diversity also describes the composition of American households. Esri uses the Census Bureau's definition of families and family households. Families include a householder and one or more people living in the same household who are related to the householder by birth, marriage, or adoption; therefore, family households are equal to the number of families. Family households can also include unrelated nonfamily members. Family households are modeled from Census 2010, Current Population Survey (CPS), and ACS data. Average family size has increased from 3.14 in 2010 to 3.16 in 2020.

The attendant change in average household size is nominal from 2000 to 2010, 2.59 to 2.58, respectively, and is back to 2.58 for 2020. The gradual change in household size has made it uniquely suitable to forecasting the change in household population from the change in households. Average household size is traditionally one of the most stable and predictable components of the forecasts. Household forecasts are predicated on local patterns of change, which are controlled to the more constant trends for states and counties.

Few block groups represent a cross-section of US households. For example, in areas that gain population from immigration, the trend in average household size is an increase. To distinguish local variation, Esri's model is keyed to the characteristics of households at the block group level. This stratification identifies several different patterns of change by household type that are applied to forecast trends in the characteristics of households—both family composition and tenure. Local change is emphasized in the 2020/2025 forecasts of households and families for counties and block groups. National and state trends are monitored with sources such as the CPS and ACS from the Census Bureau and then applied as controls.

A mixed model approach is used to forecast 2020 educational attainment and marital status, combining higher level and timelier single-year ACS data with five-year lower level ACS data. Adjustments are factored for changes to the base population's characteristics including changes to group quarters. Forecasted distributions are applied to Esri's 2020 population aged 15 years and older to update marital status. Similarly, educational attainment is updated for the population aged 25 years and older.

Housing Data

Esri's housing updates include total housing units, occupancy, tenure, and home value. Total housing unit updates are created from recorded changes in the housing inventory and estimated changes in occupancy rates since April 2010, applied to Census 2010 base data. Recorded change in the housing inventory is culled from several data sources, including multiple construction data inputs from Metrostudy, Axiometrics, data for new manufactured homes placed by state from the Census Bureau, and building permits for permit-issuing places and counties. As of 2010, only half of the counties had complete coverage with building permits. Numerous independent sources are leveraged to obtain detailed information on housing development data where no building permits exist. Independent estimates of change in occupancy are calculated from USPS residential lists, the ACS, and various state and local data sources. Additionally, data from the CPS and the Housing Vacancy Survey (HVS) from the Census Bureau is used to model trends in occupancy.

Data for tenure represents owner- and renter-occupied housing units. Together, the two components sum to total households or total occupied housing units. A time series model based on data from the HVS, combined with changes in the CPS, the ACS, and intercensal data guides tenure forecasts. With a blend of top-down and bottom-up techniques, the forecasts take advantage of the latest information from survey data at higher levels of geography while employing local characteristics at the lower levels. The small-area models leverage more geographically granular trends from ACS as well as integrate the Metrostudy and Axiometrics housing data to update an area's tenure profile. This year, the ACS tenure time series data used in the models was smoothed to further reduce survey noise by tempering outlying data points. Data from lower levels of geography is controlled to higher levels to produce the tenure updates. Changes in owner versus renter occupancy are forecasted independently and then controlled to total households. For the five-year tenure forecast, the US rate of homeownership was dampened because of the uncertain long run effects on residential real estate from the COVID-19 pandemic.

Esri reports home value for all owner-occupied housing units. Beginning with 2018, home value estimates include additional intervals to capture homes valued at $1 million to $1.5 million, $1.5 million to $2 million, and $2 million or more. A total of 13 home value intervals are reported[2]. Summary measures of home value include medians and averages that are calculated from the distributions of home value. Medians represent the middle of the distribution or the point that splits the distribution equally[3]. Medians are calculated using linear interpolation unless the median falls in the highest (>$2,000,000) interval. Following the Census Bureau's convention, this median is reported as $2,000,001 because housing value in the upper interval is top-coded to $2,000,000. Due to limited data availability for these high-valued homes, Esri top-codes average home value to $2,250,000.

Esri tracks the change in home value using several different sources, including annual estimates from ACS, the Home Price Expectations Survey™ from Pulsenomics, and the House Price Index (HPI) from the Federal Housing Finance Agency (FHFA). The Home Price Expectations Survey relies on a survey of more than 100 industry experts to forecast growth in the housing market. This forward-

[2] For a table layout, refer to downloads.esri.com/esri_content_doc/dbl/us/Var_List_Updated-Demographics_Summer2020.pdf.

[3] For more information on medians, refer to downloads.esri.com/esri_content_doc/dbl/us/Understanding_Medians.pdf

looking source is a key input to our forecasts. The HPI is designed to monitor changes in average home prices based on repeat sales or refinancing of the same properties. The index is derived from mortgage loans purchased or securitized by Fannie Mae or Freddie Mac.

Esri's 2020 and 2025 home value estimates are COVID-19 adjusted. The full brunt of the pandemic on the US housing market is unknown; we do know that the housing market is under stress. When the 2020 home value distribution was updated, construction had ground to a halt, and housing starts had dropped sharply. Supply became limited, but so too did buyers. With large swaths of the economy at a standstill, households are facing unemployment, pay cuts, and uncertainty. Despite historically low mortgage rates, the real estate market has been slow to respond. There are limited transactions to gauge change in home value; therefore, Esri has assumed a conservative minimal growth of 0.4 percent in median home value from 2019 to 2020. Esri remains conservative for the five-year forecast, projecting 2.5 percent annual change in median home value.

Esri's model emphasizes the importance of a good, stable forecast base. Employing both the ACS's historical five-year estimates and household survey data, Esri's 2020 estimates begin with an updated forecast base that leverages the growing stability of ACS data. Once every few years and particularly during real estate market cycles, it is prudent to reset the base to capture the current housing landscape. Though this does preclude comparisons to past updates, especially for small areas, the base provides a strong foundation to measure change. Local estimates of home value change incorporate supply-demand characteristics, the socioeconomic traits of householders in the area, and trends assessed for larger markets.

Esri leverages current housing and income data to provide a snapshot of affordability. Esri's approach to measuring housing affordability uses an index to quantify the ability of a typical resident to purchase an existing home in an area[4]. Employing the national average contract mortgage rate from the Federal Housing Finance Agency, an interest rate of 3.25 percent is estimated for Esri's 2020 Housing Affordability Index model. A 30-year mortgage is assumed, with a down payment of 20 percent of the home price. Regional property tax rates are determined from the latest round of the ACS, and Esri's model follows the Federal Housing Administration's guidelines for debt service ratios. Additionally, the 2020 Percent of Income for Mortgage (POIFM) quantifies the percentage of median household income dedicated to mortgage payments on a home priced at the median value.

[4] esri.maps.arcgis.com/apps/Cascade/index.html?appid=1419fe7ee70c4267a7258eb59a9a824c

Labor Force Data

Esri forecasts the 2020 employed and unemployed population aged 16+ who are either working or actively looking for work, also known as the civilian labor force. The civilian labor force does not include active-duty military, institutionalized individuals, agricultural workers, federal government employees, and those not actively looking for work. The employed population 16+ is further broken down by industry and occupation. For 2020, Esri now provides additional labor market detail with the release of employment and unemployment estimates by four age groups: 16 to 24, 25 to 54, 55 to 64, and 65 and older. These new variables were modeled using one- and five-year ACS employment and work status tables, CPS tables, and incorporate Local Area Unemployment Statistics (LAUS) trends.

Estimates of the civilian labor force integrate recent change in the supply and demand for labor from the LAUS, Occupational Employment Statistics (OES), and Current Employment Statistics (CES) programs of the Bureau of Labor Statistics (BLS), as well as the ACS and CPS from the US Census Bureau. Federal statistical surveys are the principal sources for labor force trends. The 2020 employment and unemployment estimates are developed from a block group base constructed from one- and five-year ACS labor force tables and current sources. In 2019, the ACS-derived base was updated to take advantage of the latest survey data to generate more current labor force profiles for small areas. Consequently, comparisons to Esri's labor force estimates prior to 2019 are not advised.

Esri's updated employment by industry and occupation captures temporal change from the federal statistical sources: the ACS and CPS from the Census Bureau and the CES and OES programs from the BLS. National and state industry distributions are updated using trends from the CES. The latest industry-occupation matrix from the OES is applied to allocate employment change by industry to the related occupations.

While the economy stayed on course and produced at relatively robust levels throughout 2019, GDP declined at an annual rate of 4.8 percent in Q1 2020. This drop was largely due to the impact of economic shutdowns and closures throughout the nation in response to the COVID-19 pandemic. Corresponding to this plummet in production, job losses spiked, and the pool of unemployed swelled to historic levels. To adjust for these COVID-19 impacts, preliminary estimates were first created based on prepandemic trends. Then national- and state-level adjustments were applied based on the following assumptions:

- The economic contraction and rise in unemployment will peak in the second quarter of 2020. While the downturn was sudden, recovery will be more gradual.
- Specific industries (e.g., arts, entertainment, and recreation) and occupations (e.g., food preparation and serving-related occupations) will take a disproportionate hit in employment due to the targeted restrictions in these areas of the labor market.
- Economic relief measures (such as the Coronavirus Aid, Relief, and Economic Security [CARES] Act and reduction of the federal funds target rate) provide financial support to keep affected businesses solvent so workers who were laid off or furloughed can return to their jobs. These legislative and monetary

responses, in conjunction with the ongoing shutdowns and social distancing, make a measurable impact to curb additional unemployment spikes.

- No other unexpected labor force disruptions occur that would exasperate or extend the economic downturn beyond the impacts of COVID-19 response measures.

The adjustments were made based on information from sources including unemployment insurance claims, various economic and health outlook reports, and historical trends in the business cycle. Small-area estimates were guided by the integration of weekly state-level unemployment insurance claims data.

Industries most impacted by COVID-19 restrictions suffered the highest levels of job loss. These industries were targeted at the four-digit NAICS level using data from Infogroup, allowing for a more granular approach to model the data at the local level. For example, this approach targets higher levels of employment loss in Clothing Stores (NAICS 4481) versus Grocery Stores (NAICS 4451) even though both are within Retail Trade. Adjustments were made to the employment and unemployment by age variables based on CPS proportions and the relationship between industry/occupation employment by age.

Household Income

Esri's 2020 household income estimates are reported for households as of July 1, 2020 and represent household income for the calendar year 2019. Therefore, the 2020 estimates reference a time period prior to the COVID-19 pandemic. Forecast year 2025 estimates are reported for forecasted households as of July 1, 2025, and represent household income for 2024. The 2025 household income estimates are adjusted for the impact of COVID-19. Working from the assumption that the US economy is currently in a recession, historical postrecession income recovery rates from trusted public data sources are used to guide the forecast.

Household income distributions are estimated for areas with 10 or more households only. Esri implements the definition of money income used by the Census Bureau. For each person 15 years of age or older, money income received in the preceding calendar year is summed from earnings, unemployment compensation, Social Security, Supplemental Security Income, public assistance, veterans' payments, survivor benefits, disability benefits, pension or retirement income, interest, dividends, rent, royalties, estates and trusts, educational assistance, alimony, child support, financial assistance from outside the household, and other income.

There are substantial differences between the Bureau of Economic Analysis (BEA) and the Census Bureau in estimates of per capita income. Care should be taken when comparing money estimates with other data sources since many income estimates are based solely on BEA data. Different definitions, methods of data collection, reference area, and population coverage generate different counts and measures of income.[5] BEA calculates personal income as part of its mission to produce national income accounting estimates such as the gross national product. The Census Bureau collects money income statistics to satisfy its objective to enumerate and describe the population of the United States.

5 https://www.census.gov/topics/income-poverty/income/guidance/data-sources/cps-vs-other.html

Data for consumer income collected by the Census Bureau covers money income received (exclusive of certain money receipts such as capital gains) before payments for personal income taxes, Social Security, union dues, Medicare deductions, etc.

Early in the decade, extensive testing concluded that collapsing the ACS's 16 household income intervals into fewer intervals significantly improves statistical reliability. Esri's model estimates household income by nine income intervals[6].

Estimates for household income are in nominal dollars. In other words, the growth of income attributed to inflation is included in the estimate. Esri models nominal household income directly. With inflation estimates only available at the national and regional levels and selected major cities, and a lack of local area inflation data, estimating local real household income is imprudent. Esri tracks national inflation rates to guide both current year and forecast year estimates. Expected *national* inflation is based on trends from 5- and 10-year break-even rates. These rates are computed from the spread between nominal and inflation-adjusted Treasury securities as of the end of 2019. Break-even rates represent an estimate of the average expected inflation premium that market participants are pricing into these securities over the two time horizons. The annual inflation factor is forecasted at 1.7 percent.

To estimate income for households, Esri evaluates an extensive list of sources for household income trends that include both federal and proprietary sources. The review of national surveys includes the ACS (both one-year and five-year estimates), Bureau of Economic Analysis' local personal income series, the CPS, and the Bureau of Labor Statistics' Consumer Price Index.

Esri's 2020 income estimates build on a newly updated forecast base. The forecast base capitalizes on historical ACS five-year estimates and household surveys. In any sample-based data source, both sampling and nonsampling errors contribute to the instability of time series data for small areas. Esri has designed parameters to quantify and normalize instability in its sources, producing a robust base on which to measure income change. This does, however, mark a break in the time series at the 2019 time point for household income and related variables: age by income, disposable income, and net worth.

After forecasting the state income distributions, household income is estimated for block groups. Esri's income forecasts are uniquely designed to distinguish local variation, changes in income inequality, and urbanicity as differentiators of income growth. The model correlates the characteristics of households at the block group level with changes in income. This stratification identifies several different patterns of change by household type that are applied to forecast trends in income. Modeling links the current income change to all households with similar socioeconomic characteristics. Areas with small household bases or missing base data, where the model is unable to capture the local variation, are forecast with another level of modeling to capture the change in income by strata (a group of areas classified by

[6] For a table layout, refer to downloads.esri.com/esri_content_doc/dbl/us/Var_List_Updated-Demographics_Summer2020.pdf.

their sociodemographic characteristics). Separate forecasts of the change in income by strata are aggregated to compose the income distributions.

Summary measures of household income include medians and averages that are calculated from the distributions of income. A median represents the middle of the income distribution or the point that splits the distribution equally. A median is calculated from the income intervals of the distribution using Pareto interpolation, unless the median falls in the lowest (<$15,000) or highest (>$200,000) interval. For the lowest interval, linear interpolation is used. When the median falls in the upper interval, it is reported as $200,001 because households in the upper interval are top-coded to $200,000.

Averages are computed from estimates of aggregate income. Esri's process employs unique sociodemographic methods to model distributions and aggregates simultaneously. This top-down, bottom-up approach not only provides well-grounded small-area estimates but places emphasis on the relationship between medians and averages.

Household Income by Age of Householder

Household income is reported for seven age of householder groups. The income distribution for these age groups is based on the same nine intervals as household income. Methods for median and average calculations follow those used for household income.

Household income reported by age of householder is updated to be consistent with the 2020 distributions of household income and age of householder. To update the age distribution of householders, the ratio of householders by age to the population by age in 2010 is updated to 2020/2025, taking into account the change in group quarters population applied to the current age distributions. After the targets are set, the base distributions of household income by age of householder at the block group level are fitted to current distributions of households by income and age of householder. Independent estimates of age by income are key inputs to the model.

Disposable Income

Similar to household income, disposable income is estimated in nominal dollars for nine intervals. Household income estimates are the foundation for disposable income. Disposable income estimates are also for the 2019 calendar year and are not in scope for COVID-19 adjustments. Disposable income is also reported for the seven age of householder groups. Methods for median and average calculations follow those used for household income.

Disposable income represents money income after taxes—an estimate of a household's purchasing power. The proportion of household income left after taxes is estimated from special studies conducted by the Census Bureau to simulate household taxes. Esri's 2020 disposable income incorporates data from the 2018 Annual Social and Economic Supplement of the Current Population Survey (ASEC).

Four types of taxes are deducted: federal individual income taxes, state individual income taxes, FICA (Social Security) and federal retirement payroll taxes, and property taxes for owner-occupied housing. Internal Revenue Service tax rates are used as guidelines for model testing. Esri then applies the proportions of after-tax earnings to income intervals that are cross-tabulated by age of householder for each state. State-specific proportions account for the variation in taxes by state. The

proportions, or multipliers, are then applied to the age by income forecasts for block groups and counties to calculate disposable income.

Net Worth

The 2020 update of net worth accommodates a decline in household wealth due to the abrupt economic fallout from the COVID-19 pandemic. At the time of this update, Wall Street losses had peaked at over 35 percent, with markets exhibiting extreme volatility. To account for loss in equity, as well as loss in income and potentially lost home value, Esri has built in a 12 percent decline in median net worth from 2019 to 2020.

Beginning in 2019, Esri's total net worth is reported for 12 intervals to include an upper interval of greater than $2 million. Net worth is also reported for the seven age of householder groups, by 10 net worth intervals. Summary measures of net worth include medians and averages, which are calculated from the distributions of net worth. Similar to household income methods, a median is calculated from the net worth intervals of the distribution using Pareto interpolation, unless the median falls in the lowest (<$15,000) or highest interval. For the lowest interval, linear interpolation is used. When the median falls in the upper interval, it is reported as $1,000,001 for net worth by age of householder and $2,000,001 for total net worth.

Current income is only one component of a household's financial security. Householders' net worth or accumulated wealth reflects their ability to stay afloat during a financial shock as well as their savings for future retirement. Net worth is estimated from data on household wealth that is collected from the Surveys of Consumer Finance (SCF) from the Federal Reserve Board from 1992 through 2016. These triennial surveys feature enhanced representation of wealthy households through the comprehensive measurement of net worth components. By definition, net worth equals total household assets less any debts, secured or unsecured. Assets include ownership of homes, rental properties, businesses, individual retirement accounts (IRAs) and Keogh accounts, pension plans, stocks, mutual funds, and motor vehicles. Examples of secured debt include home mortgages and vehicle loans; unsecured debt includes credit cards and other bills or certain bank loans.

Introduced in 2019, Esri's Wealth Index is compiled from a number of indicators of affluence including average household income and average net worth. The concept of wealth is defined by more than just above-average household income. Wealth also includes the value of material possessions and resources. Esri captures both income and the accumulation of substantial wealth or the abundance of possessions and resources in its identification of the wealthiest areas in the country. The index represents the wealth of the area relative to the national level. Values exceeding 100 represent above-average wealth.

2020 Geography

Current year estimates and forecasts are prepared initially for counties and block groups. County data is aggregated to Core Based Statistical Areas (CBSAs), states, or higher levels. Block group data is either aggregated directly or used with a correspondence file to produce data for census tracts, places, county subdivisions, ZIP codes, congressional districts, and designated market areas (DMAs). For user-defined sites, circles, or polygons, block weights are applied to block group data.

Changes in the geographic areas for which data is tabulated and reported are critical to the analysis of trends. Esri reports data for political and statistical areas that include states, counties, census tracts, block groups, places, county subdivisions, CBSAs, and congressional districts, plus special use areas like ZIP codes and DMAs. Of course, the provision of small-area data in Esri® software enables users to define their own areas of interest too.

Data is reported in 2010 geography for most of the standard political and statistical areas. Statistical areas, like block groups and census tracts, are defined by the Census Bureau (with help from local officials) to collect and report data for neighborhoods. Historically, these areas change every 10 years with each new census. Political areas, like counties, cities, or townships, are subject to change by local governments.

Beginning with the 2017 release, Esri incorporated major county changes since 2010:

- The former independent city, Bedford City, Virginia, is now a part of Bedford County, Virginia. Bedford City, Virginia, was dropped from the county inventory.
- Wade Hampton Census Area, Alaska, changed to Kusilvak Census Area, Alaska.
- Shannon County, South Dakota, changed to Oglala Lakota County, South Dakota.

As a result, the county database currently includes 3,142 counties. Underlying block groups, tracts, and county subdivisions reflect these changes.

This release reflects TIGER 2019 place boundaries. Census 2010 included 29,261 places; the TIGER 2019 inventory includes 29,321 places plus all the boundary changes. Note that although the number of 2019 places is the same as the number of 2018 places, the inventory has changed. Larger political areas, like counties, change less often than places.

The 2020/2025 updates reflect the metropolitan and micropolitan statistical areas released by the Office of Management and Budget (OMB) in September 2018. This release includes significant changes to CBSAs from the previous release including changes to the CBSA inventory and changes to the county compositions of CBSAs. There are 384 metropolitan and 542 micropolitan areas. Congressional districts represent the 116th Congress and TIGER 2019 CD boundaries.

ZIP codes, which are defined solely by the US Postal Service to expedite mail delivery, can change monthly or whenever the US Postal Service revises delivery routes. ZIP codes do not represent standard census geographic areas for data reporting. ZIP code boundaries are not contiguous with census geographic areas or stable over time. Data estimated for ZIP codes is also subject to change. Residential ZIP code data is estimated from block group data, using a correspondence created by assigning Census 2010 block points to ZIP code boundaries from HERE. The vintage of the ZIP code boundaries is fourth quarter, 2019; the total number of residential ZIP codes in this release is 32,056.

The integration of demographic and spatial analysis has not only enabled the development of more accurate block group totals, but it has also provided the opportunity to update block totals. Blocks are the lowest common denominator in the geographic hierarchy that progress to block groups, tracts, counties, and states. Blocks are most useful in the estimation of data for polygons, which can be any area outside the geographic hierarchy, from retail trade areas to user-defined polygons (including circles and drive-time polygons). For most areas, the application provides a good estimate for the polygon. If the relationship between the underlying blocks and the parent block groups has changed significantly since 2010, then the estimate cannot incorporate that change unless both blocks and block groups are updated.

Data Development Team

Led by chief demographer **Kyle R. Cassal**, Esri's data development team has a 35-year history of excellence in market intelligence. The team's economists, statisticians, demographers, geographers, and analysts produce independent small-area demographic and socioeconomic estimates and forecasts for the United States. The team develops exclusive demographic models and methodologies to create market-proven datasets, many of which are now industry benchmarks such as Tapestry™ Segmentation, Consumer Spending, Market Potential, and annual Updated Demographics. Esri demographics powers the ArcGIS® platform through dynamic web maps, data enrichment, reports, and infographics.

esri | THE SCIENCE OF WHERE®

Esri, the global market leader in geographic information system (GIS) software, offers the most powerful mapping and spatial analytics technology available.

Since 1969, Esri has helped customers unlock the full potential of data to improve operational and business results. Today, Esri software is deployed in more than 350,000 organizations including the world's largest cities, most national governments, 75 percent of Fortune 500 companies, and more than 7,000 colleges and universities. Esri engineers the most advanced solutions for digital transformation, the Internet of Things (IoT), and location analytics to inform the most authoritative maps in the world.

Visit us at esri.com.

Contact Esri

380 New York Street
Redlands, California 92373-8100 USA

1 800 447 9778
T 909 793 2853
F 909 793 5953
info@esri.com
esri.com

Offices worldwide
esri.com/locations

For more information, visit **esri.com/data/esri_data**.