Evaluating Current and Alternative Methods to Produce 2010 County Population Estimates

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INTRODUCTION

The U.S. Census Bureau produces estimates of the total population at the national, state, county, and subcounty levels, and total housing unit estimates are provided at the state and county levels. Population estimates are also produced by demographic characteristics (age, sex, race, and Hispanic origin) for the nation, states, and counties. The estimates are used for the distribution of federal funds by state and local governments, and as controls for Census Bureau and other surveys. As part of an ongoing effort to improve the accuracy of these estimates, the Census Bureau undertook a comprehensive research effort to evaluate both its current methods and alternative methods. This effort included research from experts internal and external to the Census Bureau. The results of this research will inform methodological decisions for the decade after the 2010 Census by providing information that will help answer the five questions below. This paper examines the accuracy of the Administrative Records (ADREC) method, which is currently used by the Census Bureau to produce county-level population estimates, and several alternative series of housing unit-based population estimates. Specifically, this paper provides information to help answer the following research questions.

1) What level of accuracy is obtained through the use of the ADREC method at the county level for different size and percent change categories?
2) Does the ADREC method produce results that are substantially better than the housing unit method at the county level?
3) Can the use of data from the American Community Survey (ACS) improve the housing unit method estimates to a level where they are comparable to the ADREC method estimates?

Two other research questions are being addressed separately by contracted researchers external to the Census Bureau.

4) Does the ADREC method have the potential to serve as an alternative or a replacement for the housing unit method at the subcounty level?

5) Can multiple indicators of population size and/or percent change be used in a regression-based method to produce population estimates that could serve as an alternative to the ADREC method?

First, we provide measures of accuracy that give historical context to the performance of the county estimates produced using the ADREC method. Then, we provide additional measures by size and percent change categories to allow for an in-depth assessment of the accuracy of the estimates produced last decade. We provide and compare measures for ADREC estimates produced with and without the incorporation of challenges from local governments and Special Censuses.[1]

Finally, we compare the accuracy of housing unit-based estimates developed using 1, 3, and 5-year estimates of occupancy rates and persons-per-household (PPH) from the ACS to the accuracy of the ADREC estimates. The Census Bureau began to assess the accuracy of estimates produced using this approach with the work of the Housing Unit Based Estimates Research Team (HUBERT) (U.S. Census Bureau, 2008). These comparisons are a continuation of the assessment of the opportunities the ACS offers for more accurate housing unit-based population estimates.

The measures we use to assess differences between the estimates and the census counts in this paper were selected through a collaborative effort with members of the Federal-State Cooperative for Population Estimates (FSCPE) and other external researchers. These measures were selected prior to the comparison work for transparency. When considered together, they are intended to provide an accuracy profile where each captures a different aspect of estimate accuracy. These measures include the mean absolute percent error (MAPE), mean algebraic percent error (MALPE), root mean squared error, percent difference thresholds, and total

[1] More information on the challenge process is available on the following website: http://www.census.gov/popest/data/historical/challenges.html.
More information on the Special Census process is available on the following website: http://www.census.gov/regions/specialcensus/.

absolute error of shares. A brief explanation and the formula for each of these measures are provided in Appendix 1 of this document.

Population estimates are developed by starting with the census count and measuring population change since the last census. Estimates of change between two censuses, both nationally and locally, reflect true change and change in net coverage between the two censuses. In comparing our estimate of change to the differences between two censuses, we are not able to distinguish between these two types of change. In this evaluation, we assume the change between Census 2000 and the 2010 Census reflects true change and assess accuracy as the degree of closeness between the population estimates and the 2010 Census counts.

COUNTY POPULATION ESTIMATES PRODUCED USING THE ADREC METHOD

Methodology

The ADREC method is an administrative records-based cohort-component approach for estimating population change, and is currently used by the Census Bureau for producing total resident population estimates at the county level.[2,3] The method starts with the most recent census count updated for boundary changes. Each cohort is then aged forward each year, and administrative records are used to estimate the components of population change: births, deaths, net international migration (NIM), and net domestic migration (NDM). The basic formula for the ADREC method is:

Population Estimate = Base Population + Births – Deaths + NIM + NDM

Each component of population change is estimated individually using administrative records or survey data, e.g., registered births and deaths, federal income tax returns, Medicare enrollees,

[2] The U.S. Census Bureau's Population Estimates methodology statements can be found at: http://www.census.gov/popest/topics/methodology/.

[3] This paper focuses on estimates for the total resident population. However, the U.S. Census Bureau also produces population estimates by characteristics and separately for the household and group quarters population.

and data from the ACS. Therefore, the accuracy of the ADREC method depends on how well each of the components of population change are approximated by the administrative or survey data sources.

The ADREC method is also used to obtain the national and state-level population estimates. With the exception of domestic migration, a national estimate is produced using the same components as the county estimates. The county estimates are controlled to the national total and summed to obtain the state estimates.

The Census Bureau has a program through which localities can challenge official population estimates. If a challenge is accepted, the revised estimate becomes the official Census Bureau estimate for that governmental unit. For this paper, two series of population estimates developed using the ADREC method are included. One incorporates challenges from local governments and results from Special Censuses; the other does not.[4] The series that does not incorporate challenges is referred to in this paper as the "Pure" ADREC series. For the series that included challenges, two different procedures were used to incorporate the results of challenges between 2000 and 2010. During the first part of the decade, the difference between the initial estimate and the challenged estimate was taken from all other non-challenging areas and the national total remained the same. This results in a decrease in the estimate for all non-challenging areas. Later in the decade, as the challenge totals started to affect the non-challenging area population estimates, the national total was allowed to change based on the number of additional people included due to new challenges. This means the national population increased by the challenge amount.

2010 Results Compared to Historical Differences

Comparisons of Estimates and Census Counts at the National Level: 1980 to 2010

Table 1 presents the numeric differences and percent differences between the population estimates and the census counts at the national level from 1980 to 2010 (U.S. Bureau of the

[4] A Special Census is a basic enumeration of population, housing units, and group quarters conducted by the Census Bureau at the request of a governmental unit. A Special Census may be requested when local officials believe there has been a significant population change in their community due to growth or annexation.

Census, 1980 and 1990). For this table, differences are calculated by subtracting the census count from the population estimate (Estimate – Census). The percent difference is calculated as follows: ((Estimate – Census) / Census) *100. A positive percent difference indicates that the population estimate is higher than the census count.

The percent difference between the estimate and the census count has varied over the decades, but was smaller in 2010 than in any of the three preceding decades. The population estimate was lower than the census count by over 2 percent in 1980 and 2000, and higher than the census count by about 0.6 percent in 1990. In 2010, the ADREC series was 0.10 percent lower than the census count, and the "Pure" ADREC series was 0.34 percent lower than the census count. These two series have different national totals because of the change in the challenge process in 2008 that allowed additional people to be included due to each challenge.

Comparisons of State and County Estimates and Census Counts: 2000 and 2010

Table 2 shows two of the measures of accuracy (MAPE and MALPE) for 2000 and 2010 for the ADREC estimate series for state and county-level data, summarized at the national level. The state MAPE decreased from 2.55 in 2000 to 1.02 in 2010. The state MALPE also improved from -2.44 in 2000 to -0.41 in 2010. Improvements were made at the county-level as well. The county MAPE decreased from 3.36 to 3.10. The county MALPE improved from -1.85 to -1.59. These results indicate that on average the estimates were closer to the census counts and had a smaller negative bias at both state and county levels in 2010 than in 2000. Table 3 shows the differences between the ADREC and "Pure" ADREC estimates series and the census counts at the state level for 2010. The state with the largest percent difference is Hawaii, where the ADREC estimates were 4.66 percent different from the census counts, and the "Pure" ADREC estimates were 4.19 percent different. New York provides the largest numeric difference, with a "Pure" ADREC estimate that is 319,253 lower than the census count (Table 3).

Previous evaluations have found that as the size of a county population increases, the MAPE decreases, and as the rate of percent change (both positive and negative) increases, the MAPE tends to be larger, and the resulting graph of MAPE by percent change shows a "U" shaped

pattern (Wetrogan, 2008). In general, we found these same patterns in our ADREC estimates series in 2000 and in 2010. Figure 1 provides the MAPEs for the ADREC series for county-level estimates by size in 2000 and in 2010, and Figure 2 provides the same for the MALPEs.[5] Figures 3 and 4, respectively, provide the MAPEs and MALPEs for the ADREC estimates series for county-level estimates in 2000 and 2010 by percent change from the previous decade.

When compared to Census 2000 counts, the estimates developed during the 1990s exhibited the previously found pattern of the "U" shaped MAPE by size (Figure 1). For 2010, the estimates again exhibit the same pattern of lower MAPEs for larger counties (Figure 1), but now show a smaller increase in the MAPE for the faster growing counties (Figure 3). As indicated by the MALPE, the estimates in 2010 still have a negative bias for almost all of the size and percent change counties, but now follow a different pattern (Figures 2 and 4). Rather than having a consistent level of bias across county size categories, the 2010 estimates have a larger negative bias for smaller counties and a smaller negative bias for larger counties, with a small positive bias (0.49) for the counties within the largest size category of 500,000 or more (Figure 2).

As was expected, the MAPEs in 2000 display a "U" shaped pattern by percent change categories, showing larger values for counties with higher (positive and negative) change from the previous census (Figure 3). However, the MAPEs in 2010 are smaller than their corresponding 2000 values for counties with large gains in population. This is particularly noticeable for the counties in the largest percent change category (greater than or equal to 50 percent) where the MAPE for these counties was 6.61 in 2000 and dropped to 3.59 in 2010 (Figure 3). Unlike in 2000, when, as would be expected, the estimates tended to overestimate the population of the counties that had the largest declines in population, the 2010 estimates tended to underestimate the size of the population in these counties (Figure 4). In addition, the estimates in 2010 had a more consistent level of bias across the other size categories than in 2000, when there was a large negative bias for the fastest growing counties.

[5] Population size categories for 2010 are based on Census 2000 population. Population size categories for 2000 are based on 1990 Census population.

Counties range in size from the smallest, Loving County, Texas, with a population of 82 in 2010, to the largest, Los Angeles County, California, with a 2010 population of 9,818,605 (U.S. Census Bureau, 2011). The 2000 estimates (which are based on the 1990 Census count), show that 300, or 10 percent, of counties had a population of less than 5,000, and 458, or 15 percent, had populations of at least 100,000 (Figures 1 and 2). As counties experienced different levels of change throughout the decade, the distribution of counties by size changed. The 2010 estimates (which are based on the Census 2000 count), show that 9 percent of counties still had a population of less than 5,000. Only 0.27 percent of the national population resided in these counties. Seventeen percent of counties had populations of at least 100,000 and 77.81 percent of the national population resided in these counties (U.S. Census Bureau, 2011).

Between 2000 and 2010, 1,104 counties lost population (Figures 3 and 4). Saint Bernard Parish, LA, whose population declined by 31,333, or 46.61 percent, experienced the highest percent loss in population. Kendall County, IL, whose population increased by 60,206, or 110.41 percent, experienced the largest percent increase in population (U.S. Census Bureau, 2011).

The MAPE and MALPE indicate that the accuracy of population estimates improved from 2000 to 2010. The largest improvements were in the larger county population size and larger percent change categories. There was also a notable increase in the negative bias for smaller counties and a decrease in the negative bias for larger counties in 2010. The decrease in negative bias for larger counties can be partly attributed to a 2010 national-level estimate that was closer to the census count due to improved estimates of international migration over the decade.

Comparisons between the ADREC and "Pure" ADREC Series

In this section, we compare the performance of the ADREC series to the "Pure" ADREC series and provide additional measures of accuracy by size and percent change categories. These comparisons allow us to better understand the impact of incorporating challenges from local governments into the estimates. The incorporation of challenges into the estimates can impact an area directly when it is for the county or a subcounty area within the county. Challenges can also impact other areas indirectly depending on the methodology used to incorporate the challenge.

These comparisons will also provide additional information on the level of accuracy of the Census Bureau's current method for producing estimates at the county level for different population size and percent change categories.

During the 2000s, 170 counties either challenged the Census Bureau's population estimate or requested a Special Census (Table 4). These challenges or Special Censuses could have been at the county level or for a smaller governmental unit (such as a city) within that county, and some of these geographies challenged multiple times throughout the decade. Of these 170 counties, 129 had challenges and 44 had Special Censuses (three counties had both challenges and Special Censuses). Of the 129 challenge counties, the "Pure" ADREC estimate was closer than the ADREC (challenge) estimate to the census count for 73 (or 57 percent) of these counties. Of the ten largest challenge counties, the "Pure" ADREC estimate was closer to the census count for eight counties. Of the ten smallest challenge counties, the "Pure" ADREC estimate was closer for six counties. Of the ten fastest losing counties, the "Pure" ADREC estimate was closer for seven counties, and of the ten fastest gaining, the "Pure" ADREC estimate was also closer for seven counties.

Table 4 shows that of the 129 counties with challenges, 46 were at the county level and 87 were at the subcounty level (four counties had challenges at both the county level and subcounty level of geography within that county). The 46 counties that challenged their population estimates tended to be large counties. Eight of these counties had a Census 2000 population of over one million, and the average Census 2000 county population size for these counties was 549,791. Based on Census 2000 and the 2010 Census, six of these counties lost population over the last decade, and 63 percent of these counties grew less than 10 percent. Out of the 46 county level challenges, the "Pure" ADREC estimate was closer to the census count for 26 counties, or 57 percent (Table 4). For the subcounty level challenges, the "Pure" ADREC estimate was closer to the census count for 50 counties, or 57 percent.

County-Level Differences

Figure 5 shows the distribution of percent differences between each estimate series and the census counts for 2010 at the county level. The distribution is skewed to the right, with estimates for most counties being lower than the census counts. Out of the total 3,143 counties, the ADREC series has 768 counties (24 percent) that were within +/-1 percent of the census count; the “Pure” ADREC series has 883 counties (28 percent).

Percent differences between the estimates and the census counts for each county range from -30.49 percent to 45.56 percent (Table 5). The largest negative percent difference is found in Loving County, Texas, where the estimated population of 57 is 25 less than the census count. The largest positive percent difference is found in Kalawao County, Hawaii, where the estimated population of 131 is 41 more than the census count. Both of these counties have very small populations. In the ADREC series, 63 percent of counties fall between +/-3 percent of the census count, as do 66 percent of counties in the “Pure” ADREC series (Figure 5).

In the ADREC estimate series, 926 counties have positive percent differences; in the “Pure” ADREC series, there are 1,089. The ADREC series has 2,214 counties with negative percent differences, and the "Pure" ADREC series has 2,052. Three counties have census counts that are equal to their ADREC estimate; two counties have census counts that are equal to their “Pure” ADREC estimate (Figure 5). The ten counties with the largest negative percent differences are the same (and in the same order) in both estimate series, although values are not the same. Eight of the ten counties with the largest positive percent differences are the same in both series, but again the values are not the same (Table 5).

Of the ten counties in the ADREC series with the largest negative percent differences, the county with the largest population size is Telfair County, Georgia, with a 2010 Census count of 16,500, and a percent difference of -22.13. Of the ten counties in the ADREC series with the largest positive percent differences, the county with the largest population size is Finney County, Kansas, with a 2010 Census count of 36,776, and a percent difference of 16.66 (Table 5). Of the ten counties in the “Pure” ADREC series with the largest negative percent difference, the largest

county is also Telfair County, Georgia, with a percent difference of -21.74. Of the ten counties in the "Pure" ADREC series with the largest positive percent differences, the largest county is Accomack County, Virginia, with a 2010 census count of 33,164, and a percent difference of 16.52 (Table 5).

The differences between the two series in the numbers of counties with positive and negative differences is largely a result of the method used to incorporate challenges prior to 2008. Prior to 2008, the difference between the challenge estimate and the initial estimate was taken from all other non-challenging counties. This resulted in lower estimates for non-challenging areas.

County-Level Measures

For all counties, the ADREC series has a MAPE of 3.10 and a MALPE of -1.59 (Table 6). The "Pure" ADREC series has a MAPE of 2.91 and a MALPE of -1.28. The ADREC series has 558 counties that exceed the 5 percent difference threshold and 110 counties that exceed the 10 percent difference threshold. The "Pure" ADREC series has fewer outliers, with 504 counties that exceed the 5 percent difference threshold and 103 counties that exceed the 10 percent difference threshold. Although the ADREC series is closer to the 2010 Census counts for the total population at the national level, the "Pure" ADREC series slightly outperforms the ADREC series when looking at these three measures of accuracy for all of the counties in the nation.

County-Level Measures by Size

The MAPE and MALPE for both estimates series generally improve as the population size increases (Table 7). The MALPEs for both series are negative for the smallest counties (ADREC -4.15, "Pure" ADREC -3.69) and get increasingly closer to zero as the population size increases. With the exception of the ADREC estimates for the largest size category (which has a MALPE of 0.49), there is a negative bias, or a tendency to underestimate the population, for counties in all of the size categories. The corresponding MALPE for the "Pure" ADREC series is still negative (-0.19) for this category. This illustrates that the incorporation of challenges associated with these larger counties shifts the bias from a slightly negative 0.19 to a positive 0.49. For

example: Kings County, NY, Queens County, NY, and Fulton County, GA all had challenge estimates that were over 100,000 above their "Pure" ADREC estimates.

While both estimates series produce similar results, the ADREC series tends to result in slightly more counties that exceed the percent difference thresholds (+/-5% and +/-10%). In order to account for differences in the number of counties between categories, the percent of counties that exceed the percent difference thresholds is calculated. This is calculated by dividing the number of counties in each category that exceed the percent difference thresholds by the total number of counties within that category. The percent of counties that exceed the percent difference thresholds also generally decreases as the size categories increase. While the "Pure" ADREC series outperformed the ADREC series at almost every size category, and for almost every measure, the differences between the two series were not large. These small differences reflect both the impact of the individual challenges on their own population estimate and the impact of the methodology used to incorporate them.

The number of counties that exceed the percent difference thresholds also generally decreases as the size categories increase. For instance, for counties with less than 5,000 people, the ADREC series has 151 counties that exceed the 5 percent difference threshold and 49 counties that exceed the 10 percent difference threshold. The "Pure" ADREC series performs slightly better with 146 counties that exceed the 5 percent difference threshold and 46 counties that exceed the 10 percent difference threshold.

For the most populous counties (those with at least 500,000 people), the ADREC series has 8 counties that exceed the 5 percent difference threshold and one county exceeding the 10 percent difference threshold. Of the 8 counties exceeding the 5 percent difference threshold, 5 had a challenge incorporated at some point during the decade. All 5 of these counties exceed the higher end of the threshold, meaning that the estimates were higher than the census count, and two of the counties without a challenge exceed the lower end of the threshold. In contrast, the "Pure" ADREC method has only one county exceeding the higher end of the 5 percent difference threshold (Maricopa County, AZ) and none exceeding the 10 percent difference threshold. The

fact that the ADREC method has more counties exceeding the percent difference thresholds can be attributed to challenges in those counties.

County-Level Measures by Percent Change

Table 8 provides the measures of accuracy by county percent change categories. The MAPEs for both series are the highest for counties with the largest relative loss of population (decrease in population from 2000 to 2010 of 10 percent or more), with values of 4.85 for the ADREC series, and 4.79 for the "Pure" ADREC series. Furthermore, the MAPEs for both series decrease as they approach zero percent change, and then generally increase again as the percent change increases. The "Pure" ADREC estimate series performs slightly better than the ADREC series in all percent change categories except for counties that grew 50 percent or more. For the counties in this category, the MAPE was 3.59 for the ADREC series and 3.65 for the "Pure" ADREC series. The lower MAPE for the ADREC series is partly the result of a Special Census in Pinal County, Arizona.

Continuing with Table 8, we note that the MALPEs for both estimates series are negative for every percent change category. The MALPEs are small for the largest negative percent change category (ADREC -0.32, "Pure" ADREC -0.11) and get larger as the percent change becomes more positive, except for the largest positive percent change size category (50+ percent), where the MALPE is less negative than the preceding percent change category (25 to 49.9 percent). The percent of counties that exceed the percent difference thresholds is highest around large (positive and negative) rates of percent change (Table 8). Overall, the "Pure" ADREC series outperforms the ADREC series by percent change category. However, once again the differences between the two series are not large.

County-Level Measures by Size and Percent Change

When looking at county-level measures by both size and percent change, we find that the largest MAPEs and MALPEs are found in the category with the smallest counties and high positive percent change (Table 9). However, it is important to note that there are only a small number of counties in these categories. The MAPEs are largest for the 13 counties of less than 10,000

people that grew 25 to 50 percent (ADREC 13.95, “Pure” ADREC 13.54). The MALPEs for these same counties have the exact same value; only negative (ADREC -13.95, “Pure” ADREC -13.54). The MAPEs and MALPEs are the same value when the sign is not considered, which indicates every county in these categories had an estimate that was lower than the census count.

The smallest county size category also has the highest number of counties that exceed the percent difference thresholds. The majority of these counties are found in the categories of decreasing or slightly increasing percent changes. Excluding the three counties that lost over ten percent of their county population, the largest MAPEs among the most populous counties (65,000+), are in the counties that grew 25 to 50 percent (ADREC 2.33, “Pure” ADREC 2.16). Generally, the counties in this size category that had a low or medium amount of positive growth have the largest MALPEs, again excluding the three counties that lost over ten percent of their population.

For almost all size and percent change categories, the incorporation of challenges generally leads to less accurate estimates. However, the differences between the two series were not large. Overall, there was a substantial shift from a tendency to underestimate the population to a tendency to overestimate the population. The ADREC and “Pure” ADREC estimates both perform well and follow expected patterns of accuracy across all size and percent change categories. Larger counties tend to have more accurate estimates than smaller counties, and fast growing counties tend to have less accurate estimates than slow growing counties. The estimates are the least accurate for counties that lost population, but tend to accurately measure high levels of change. On average, the “Pure” ADREC method outperforms the ADREC method with few exceptions. Out of the 129 counties or subcounties that challenged their population estimate, the original “Pure” ADREC estimate is closer to the census count than the revised ADREC estimate 57 percent of the time (Table 4).

COUNTY ESTIMATES PRODUCED USING THE HOUSING UNIT (HU) METHOD

As a part of an ongoing effort to consider alternatives to the ADREC method, we examine several housing unit-based methods. Housing unit-based approaches follow the model identified in the Housing Unit Method, which is based on the assumption that everyone in the household population in an area can be linked to a housing unit in which one household resides (Smith and Cody, 2006). Therefore, changes in the household population will be reflected in changes in the number of housing units, average household size, and occupancy rates. Adding the population living in group quarters to the household population gives an estimate of the total population in an area.

The "Pure" ADREC series is the best representation of the results obtained using the ADREC method, therefore, we will focus on these estimates in relation to the alternative series for the rest of the paper. This section focuses on comparing the performance of the "Pure" ADREC series to the estimates produced using the housing unit-based approach at the county level. The analysis provided in this section will help answer the second research question: Does the Census Bureau's current method produce results that are substantially better than the housing unit-based methods at the county level?

In addition to the comparisons with the "Pure" ADREC estimate series, comparisons are also made between housing unit-based estimates developed using either decennial census data or ACS data. The ACS offers a previously unavailable nationwide, county-level data source for estimating change in persons per household (PPH) and occupancy rates. In this paper, the use of ACS 1-, 3-, and 5-year data is examined to help us understand how data from the ACS could best be used in a housing unit-based methodology.[6] Additionally, we examine several experimental series that include the use of decennial census data for the components of the housing unit-based estimates. By substituting census data for estimated values, these additional estimates allow for a

[6] This evaluation examines the use of ACS 1-year data at different county size and percent growth categories, but the U.S. Census Bureau does not recommend using ACS 1-year data to analyze small populations due to its smaller sample size.

better understanding of the contribution each component makes to the error in the housing unit-based estimates.

Methodology

With the Housing Unit Method, the total population is estimated by multiplying the number of housing units by an occupancy rate and PPH. The group quarters population is then added. This methodology is used along with the ADREC county-level population estimates in the Census Bureau's distributive housing unit methodology at the subcounty level. The formula for the housing unit method is:

$P_t = HU_t * O_t * PPH_t + GQ_t$

HU = Number of housing units

O = Occupancy rate

PPH = Persons per household

GQ = Group quarters population

t = time

For this analysis, we apply this formula at the county level. A number of different iterations of the housing unit-based estimates are examined. Occupancy rates and PPH come from either the ACS or decennial census data. Without the application of a higher-level control, the housing unit-based estimates may exhibit a positive or negative bias due to general trends in either PPH or vacancy rates. To account for a possible bias in the housing unit-based estimates, series were also produced using state and national controls. In total, 14 housing unit-based population estimate series were created. Although geometric extrapolations and regression models have been shown to produce more accurate estimates of PPH than simply using the value from the most recent census, no attempts were made to assess other techniques that have been developed and are commonly used to estimate changes in occupancy rates and PPH (Smith et al., 2002; Swanson and Hough, 2007). Instead, the potential accuracy of a housing unit based approach is examined by substituting known census values for estimated components of the housing unit method. Results from these series are provided in the next section of this paper.

ACS Housing Unit-Based Population Estimates

The ACS data in our analysis are weighted using uncontrolled sample weights adjusted for nonresponse. The weighting accounts for the probability of being selected and for households that do not respond to the survey. The data are not controlled to external housing unit or household population estimates to avoid complications arising from using data that have been controlled to the population estimates. The statistical controls used by the ACS to account for it being based on a sample should not be confused with the national and state-level controls used to account for bias in the housing unit method.[7]

The nine housing unit-based population estimates series below use ACS data. All of these series use estimates of housing units for April 1, 2010 produced by the Census Bureau's Population Estimates program, and occupancy rates and PPH from the ACS. The names used to represent each of the nine series are shown in the table below. Each series' name identifies the source of the occupancy rates and PPH and which controls (either none, state, or national) are applied to the resulting estimates.

ACS Housing Unit-Based Population Estimates Series Labels

Source: Occupancy Rates and PPH	**Control:** None	**Control:** ADREC State Population Totals	**Control:** ADREC National Population Totals
ACS 1-Year	ACS 1-Year	ACS 1-Year - ADREC state control	ACS 1-Year - ADREC national control
ACS 3-Year	ACS 3-Year	ACS 3-Year - ADREC state control	ACS 3-Year - ADREC national control
ACS 5-Year	ACS 5-Year	ACS 5-Year - ADREC state control	ACS 5-Year - ADREC national control

[7] A simplified example: If the ACS selects 100 addresses for a county and 80 of the 100 are found to be occupied, the uncontrolled occupancy rate would be 80 percent. If in the 80 occupied housing units the ACS recorded 160 people, the PPH would be 2. If the housing unit control was 1,000, and the population control was 2,000, the occupancy rate would remain at approximately 80 percent and the PPH would become 2.5.

In the table above, the first column, which contains the name of the population estimates series, identifies the source of the occupancy rates and PPH. The second column contains the names of the three estimates series that are not controlled to a higher geography level. The third column contains the names of the three estimates series that are controlled to ADREC state population totals. The fourth column contains the names of the three estimates series that are controlled to ADREC national population totals. For example, the ACS 3-year – ADREC state control population estimates series is named to indicate that this series of estimates uses occupancy rates and PPH from the ACS 3-year file, and the resulting population estimates are controlled to the ADREC State estimates.

Initially, this analysis will be limited to comparisons between the accuracy of the "Pure" ADREC method estimates and the ACS 5-year ADREC estimates with and without the state control. The 5-year estimates are selected because they generally outperformed the others. Then, results from using the ACS 1-year and 3-year data are compared to the "Pure" ADREC and ACS 5-year estimates across population size and percent change categories.

Experimental Housing Unit-Based Population Estimates

By substituting the measured value from the census for each of the components, we are able to see the level of accuracy obtained when what would be essentially a perfect estimate of that component is used. Regardless of the accuracy of the technique used to estimate the occupancy rate or PPH, the results are not expected to be as accurate as when a perfect estimate of that component is used. It is important to note that these experimental series do not represent estimates that would be possible to produce during a postcensal period. They are included in this analysis to isolate the error of the different components in the housing unit methodology.

Our experimental series include five housing unit-based estimates series that use decennial census data. Three of these series use Census 2010 occupancy rates and PPH, estimated housing units, and state and national-level controls. A fourth series uses ACS 3-year occupancy rates and PPH with Census 2010 HUs instead of estimated housing units. This allows for a more direct assessment of the error due to the use of the ACS estimates of occupancy rates and PPH. A fifth,

and final series, uses Census 2000 occupancy rates and PPH, and estimated housing units. This series reflects the methodology previously used in the challenge process. This series will be included in the comparison with the ACS 5-year estimates. The names used to represent each of the five series are shown in the table below. Again, each series' name identifies the source of the occupancy rates and PPH and which controls (either none, state, or national) are applied to the resulting estimates.

Experimental Housing Unit-Based Estimates Series Labels

Source: Occupancy Rates and PPH Source	**Control:** None	**Control:** ADREC State Population Totals	**Control:** ADREC National Population Totals
Census 2010	Census 2010	Census 2010 - ADREC state control	Census 2010 - ADREC national control
ACS 3-Year	ACS 3-Year with Census 2010 HUs		
Census 2000	Census 2000 housing unit-based		

Comparisons between the ADREC and Alternative Housing Unit-Based Population Estimates Series

National-Level Differences

Table 10 shows the differences between the population estimates for the selected series at the national level. At this level, the ACS 5-year estimates result in a large underestimate of the population, while the Census 2000 housing unit-based estimates result in a large overestimate of the population. The ADREC estimates series produces population totals closest to the census counts, coming in 295,054 (0.1 percent) under. While the "Pure" ADREC estimates are 1,064,208 (0.34 percent) under the census count, the ACS 5-year estimates are 13,165,157 (4.26 percent) under the census count, and the ACS 5-year ADREC state control series produces the same difference as the ADREC series due to the control. The Census 2000 housing unit-based

estimates are 7,262,126 (2.35 percent) over the census count. The large underestimate from the ACS 5-year series is due to the tendency for the uncontrolled ACS occupancy rates and PPH to be lower than the 2010 Census values. The tendency for the Census 2000 occupancy rates and PPH to be higher than the 2010 Census values contributes to the large overestimate from the Census 2000 housing unit-based series.

County-Level Measures

Although Table 10 shows that the ADREC series is closer to the census counts at the national level for the total population, Table 11 shows that when all of the counties in the nation are evaluated with the measures of accuracy, the "Pure" ADREC estimates series outperforms the alternative series. The "Pure" ADREC series has the lowest values for all of the measures except for the MALPE where the ACS 5-year ADREC state control series has a lower value. The total absolute error of shares value provides a measure of how well each series estimates the distribution of population, regardless of the accuracy of the estimate at the national level. Table 11 shows that the "Pure" ADREC series has a lower total absolute error of shares value than the alternative series.

County-Level Measures by Size

Figure 6 shows the MAPEs for the three selected series and the "Pure" ADREC series by county population size. As expected, the smallest counties (less than 5,000) has the highest MAPE values. The MAPEs generally decrease as the population size increases. The figure illustrates how the "Pure" ADREC series outperforms the other series for all of the county population size categories. For the majority of size categories, the "Pure" ADREC series outperforms the other series by a large margin. Figure 7 shows the MALPEs for the same series by county population size. We can see from Figure 7 that the ACS 5-year series generally underestimates the population, while the Census 2000 housing unit-based series tends to overestimate the population.

The "Pure" ADREC series has a negative MALPE for all size categories, with the smallest counties having the largest MALPEs. For the "Pure" ADREC series, the MALPE gets closer to

zero as the counties get larger; whereas for the ACS 5-year estimates, the MALPE generally becomes increasingly negative as the counties get larger. The ACS 5-year ADREC state control series has a positive MALPE for the smallest counties, and the value generally decreases as the counties get larger. As was seen when all counties were considered together, the ACS 5-year ADREC state control series shows the lowest bias. The Census 2000 housing unit-based series stands out as having a large positive bias across all county population sizes. The large positive bias is particularly notable for the smallest counties. Again, the Census 2000 housing unit-based series was important for us to include because of its use in the challenge process at the county-level in the 2000s.

County-Level Measures by Percent Change

Figure 8 presents the MAPEs for the same four series by the percent change in county population size from 2000 to 2010. Generally, the MAPEs are largest for counties with the largest relative gains and losses in the population. The MAPE for the Census 2000 housing unit-based series is particularly large (19.75) for counties that experienced the highest level of population decline (loss of 10 percent or more). The "Pure" ADREC series outperforms the other series in every population change category.

Figure 9 shows the MALPEs for these series by percent change in county population from 2000 to 2010. The "Pure" ADREC series has a small, negative MALPE (-0.11) for counties with the largest percent decline in population, while the other three series produce much larger, positive values. With the exception of the "Pure" ADREC series, most series generally overestimate the population in counties that lost high percentages of their population; while the population of faster growing counties is increasingly underestimated. In particular, the Census 2000 housing unit-based population estimate series performs the worst among counties with the highest percent loss in population, while the ACS 5-year series performs the worst among counties with the highest percent gain in population.

County-Level Measures by Size and Percent Change

Table 12 contains the measures for these selected series by both size and percent change. Regardless of the size categories, the MAPEs and MALPEs for all four estimates series tend to be larger around greater (both positive and negative) percent change. Based on previous work, this is expected. For the 164 smallest counties (with a population less than 10,000) that saw the largest percent decrease in size (loss 10 percent or greater), the “Pure” ADREC series performs much better than the alternative series according to the different measures of accuracy. The “Pure” ADREC series has a MAPE of 4.69 and a MALPE of -0.92. Thirty-four percent of counties exceed the 5 percent difference threshold, and nine percent of counties exceed the 10 percent difference threshold. With a MAPE of 9.03 and a MALPE of 6.47, the ACS 5-year series is the second-best performing series. Sixty-three percent of this category’s counties for this series exceed the 5 percent difference threshold, and thirty-four percent exceed the 10 percent difference threshold. The Census 2000 housing unit-based population estimate series has the least accurate measures, with both a MAPE and MALPE of 19.85. All 164 of these counties exceed both of the percent difference thresholds in the Census 2000 housing unit-based population estimates.

To look at the other end of the spectrum, we examine the twenty largest (population of 65,000+), fastest growing (growth of 50+ percent) counties. Once again, we see that the "Pure" ADREC series outperformed the alternative series. The "Pure" ADREC series has a MAPE of 1.74 and a MALPE of 0.05. Five percent of counties exceed the 5 percent difference threshold, and there are no counties that exceed the 10 percent difference threshold. The ACS 5-year ADREC state control series is the second-best performing series, with a MAPE of 4.20 and a MALPE of -1.17. Thirty percent of this category’s counties for this series exceed the 5 percent difference threshold, and ten percent exceed the 10 percent difference threshold. The ACS 5-year series performs the worst on the measures of accuracy, with a MAPE of 7.04 and a MALPE of -6.69. Fifty percent of the counties in this category exceed the 5 percent difference threshold for this series, and thirty percent exceed the 10 percent threshold.

ACS 1-, 3-, and 5-Year Housing Unit-Based Population Estimates

Next, we compare the results from using the ACS 1-, 3-, and 5-year data to the "Pure" ADREC estimates across population size categories. This allows for an assessment of the trade off between the more current 1-year ACS estimates and the larger sample size of the 5-year estimates. This helps address the third research question: Can the use of data from the ACS improve the housing unit method estimates to a level where they are comparable to the ADREC method estimates at the county level?

The ACS provides estimates of occupancy rates and PPH, and two sources of error in these rates are timeliness and sampling error. By using ACS 1-, 3-, and 5-year data, we can examine the effects of timeliness and sample size. It is possible that using a combination of ACS estimates could result in a more accurate series of estimates. For large faster growing counties, ACS 1-year data could be used, and for smaller, slower growing counties, ACS 5-year data could be used.

Figure 10 shows the MAPEs for the "Pure" ADREC series, the ACS 1-year series, the ACS 3-year series, and the ACS 5-year series by county population size. The smallest counties produce the largest MAPE values, and these values generally decrease as population size increases but eventually begin to increase again for larger counties. Across all size categories, the ACS 5-year estimates have the lowest MAPE among the ACS estimates. These size categories include a combination of fast and slow growing counties. When the MAPE is calculated by size and percent change categories (Table 13), it tends to be larger for counties with larger (both positive and negative) change, which is expected. However, there are not as many counties in these categories.

Figure 11 shows the MALPEs for the same series by county size. The MALPE values are negative across all county size categories. In general, the MALPEs for the "Pure" ADREC series improve as county size increases. On the other hand, the MALPEs for the three ACS housing unit-based series generally worsen as the county size increases. This chart also shows that the "Pure" ADREC series has the largest negative MALPE for the smallest counties but outperforms the other series at almost all of the other county size categories. Among the ACS

estimates, the ACS 5-year series has the smallest MALPEs. When the MALPE is calculated by size and percent change categories, it tends to be larger for counties with larger (both positive and negative) change, similar to the pattern that was shown with the MAPE (Table 13). The "Pure" ADREC series tends to outperform the alternative series for most of the county population size by percent change categories by MALPE.

Experimental Housing Unit-Based Population Estimates

In order to isolate the error of the different components, experimental housing unit-based population estimates series were created. These series use decennial census data for various components in the housing unit methodology. We examine the performance of the three series that use an estimate of housing units, Census 2010 occupancy rates and PPH, and population controls applied at various geographic levels. These series are Census 2010, Census 2010 ADREC state control, and Census 2010 ADREC national control. Substituting decennial census data for estimates of occupancy rates and PPH isolates the impact of the housing unit estimates, since it effectively reflects having perfect estimates of occupancy and PPH. We also examine the performance of the ACS 3-year – Census 2010 HUs series. This series uses ACS 3-year occupancy rates and PPH with 2010 Census housing units (instead of the estimate of housing units that all of the other estimate series use). This allows for a more direct assessment of the error due to using ACS occupancy rates and PPH, since it effectively reflects having perfect housing unit estimates.

Figure 12 shows the MAPEs for these four series along with the "Pure" ADREC series by county size. Like the other series that have been examined, the MAPEs generally decrease as the population size increases. The "Pure" ADREC series outperforms the alternative series for each county size category, and the ACS 3-year – with Census 2010 HUs series has the highest MAPEs for each county size category. This indicates that, even if we were able to estimate the change in housing stock with 100 percent accuracy, the error from the ACS values (occupancy rates and PPH) alone would result in estimates that are less accurate than the "Pure" ADREC estimates.

Figure 13 shows the MALPEs for these same series by county size. Again, we see that the "Pure" ADREC series has a larger negative MALPE for the smallest counties and the MALPE becomes closer to zero as the population size increases. The Census 2010 series, Census 2010 ADREC state control series, and the Census 2010 ADREC national control series all have positive MALPEs for the smallest counties, and then the MALPEs generally become increasingly smaller and turn negative as the population size increases. The ACS 3-Year – with Census 2010 HUs series has the largest negative MALPEs with higher values for the smallest and largest sized counties. While the series that use Census 2010 occupancy rates and PPH provide estimates that come close to achieving the same level of accuracy as the "Pure" ADREC method estimates, these series are only illustrative and do not represent estimates that would be possible to produce during an intercensal period. They were included in this paper to isolate the error of the different components in the housing unit methodology.

SUMMARY

When compared to their corresponding census counts, the Census Bureau's 2000 and 2010 county population estimates show a high level of accuracy across size and percent change categories. ADREC estimates for the 2000 to 2010 period are more accurate than those produced for the 1990 to 2000 period, when considering various measures of accuracy for county population size and percent change categories. This may be partly due to a more accurate estimate of the national population resulting from the incorporation of estimates of international migration developed from the ACS. Substantial improvements were made for counties with populations of 100,000 or more and counties that grew by 25 percent or more. However, counties with populations of less than 10,000 people saw a small increase in their average error and negative bias.

While the ADREC estimates for 2010 tend to follow the expected patterns of accuracy, an exception is the decrease in accuracy typically seen for the fastest growing counties. As was expected, estimates are less accurate for smaller and faster changing (both positive and negative)

counties. However, the estimates continue to have a high level of accuracy for the fastest growing counties. The MAPE for counties that grew by 50 percent or more is 3.59, and the MALPE is -1.53. This can be compared to last decade where the MAPE for the same percent change category was 6.61 and the MALPE was -5.21. While the MAPE follows the expected pattern of being lower for larger counties, there is little difference in accuracy for the size categories above 100,000. When the MAPE is viewed for the percent change categories, the familiar "U" shaped pattern found in previous evaluations was barely visible.

The "Pure" ADREC estimate series, which was produced without the incorporation of challenges or Special Censuses, is also compared with the 2010 Census counts. On average, the incorporation of challenges and Special Census results makes county estimates slightly less accurate, although there are some exceptions. Counties with populations between 10 and 20 thousand that decreased 10 percent or more improve when challenges and Special Censuses are included. For these estimates, the MALPE improves from 3.37 to 2.87 while the MAPE decreases slightly from 4.46 to 4.26.

The comparison with the alternative housing unit-based population estimates series reveals a large disparity between the accuracy of the "Pure" ADREC method estimates and the alternatives. The series that used ACS 5-year data has a large negative bias. At the national level, the ACS 5-year series underestimates the population by 13.2 million, or 4.26 percent. This bias is reflected in the county-level MALPE of -2.81. Using ACS 5-year data, the county-level MAPE is 5.80, which can be compared to a county-level MAPE of 2.91 for the "Pure" ADREC estimates. The ACS 5-year estimates generally perform only slightly better for county population categories of less than 250,000 than when using occupancy rates and PPH from Census 2000. For size categories larger than 250,000, the use of ACS 5-year data results in estimates that are on average less accurate than when using occupancy rates and PPH from Census 2000. However, the use of a state control results in improved ACS 5-year estimates, especially for the larger county categories. For counties greater than 500,000 the use of a state control reduces the MAPE from 4.86 to 2.02.

The ACS 5-year estimates perform better than the ACS 3-year and the ACS 1-year estimates across all size categories. For the highest positive percent change category, both the ACS 3-year and ACS 5-year estimates perform better than the ACS 1-year estimates, which was unexpected as the 1-year estimates include only the results from the most current year. This result suggests that the error due to the reduced sample size is greater than the reduction in error from the use of only the more recent year of data.

Several experimental series of population estimates were produced to allow for a more direct assessment of the error that can be attributed to each component of the housing unit estimates. The results of these illustrative estimates indicate that the error from each component individually is enough to result in a series of estimates that is less accurate than the "Pure" ADREC method estimates. This means that even if it were possible to obtain perfect estimates of either housing units or the combined occupancy rates and PPH, the resulting estimates would still be less accurate than the "Pure" ADREC method estimates.

In summary, the Census Bureau's county-level population estimates continue the trend toward increased accuracy. The use of data from the ACS for estimating net international migration likely was a factor in a national-level estimate that is only 0.10 percent lower than the 2010 Census count. The accuracy of the national-level estimate along with methodological improvements made to the ADREC method throughout the decade results in a series of county-level estimates with a high level of accuracy. A comparison with alternative housing unit-based estimates shows that even with the use of estimates of occupancy rates and PPH from the ACS, the use of the housing unit method results in estimates that are considerably less accurate than the ADREC method estimates.

In addition to providing information on the accuracy of the Census Bureau's ADREC method, this analysis also continues the examination of the use of the Housing Unit Method started as part of the Housing Unit Based Estimates Research Team (HUBERT). Housing unit-based approaches to estimating population will continue to be of use to state and local demographers developing estimates for subcounty levels of geography. However, at this point, when

developing a nationwide series of county population estimates, they do not provide a level of accuracy that is comparable to the ADREC method.

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Appendix 1. Measures of Accuracy

Five measures of accuracy, chosen in advance of the evaluation, were selected to provide an accuracy profile of the various series of population estimates. They represent summary measures of accuracy across an evaluation geographic level. For example, overall national-level measures of accuracy were computed for accuracy of state and county-level estimates. The measures are:

Mean Absolute Percent Error (MAPE) = $((\sum ((|\text{Estimate} - \text{Census}|)/\text{Census}))/N)*100$

This measure takes the absolute value of the difference between the estimate and the census value for each evaluation geography, divides that by each respective census value, sums them, divides by the number of evaluation geographies, and multiplies the result by 100. The goal is to provide a relative measure of error. This is one of the most commonly used measures for assessing the accuracy of a series of estimates.

Mean Algebraic Percent Error (MALPE) = $((\sum((\text{Estimate} - \text{Census})/\text{Census}))/N)*100$

Similar to the MAPE, this measure takes the difference between the estimate and the census value for each evaluation geography, divides that by each respective census value, sums them, divides by the number of evaluation geographies, and multiplies the result by 100. Its purpose is to identify systematic bias and provide an alternative for a relative measure of error.

Root Mean Squared Error = $SQRT(\sum ((\text{Estimate} - \text{Census})^2)/N)$

This measure squares the difference between the estimate and the census number for each evaluation geography, sums these values across evaluation geographies, divides by the number of evaluation geographies, and finds the square root of this value. It presents an alternative measure that places greater emphasis on large numeric errors versus mean absolute errors.

Percent Difference Thresholds = Number of percent differences above a certain threshold

Unlike the other measures, this is a numeric value that relies upon an arbitrarily set threshold (e.g., 5 and 10 percent). In short, the percent difference is computed by dividing the difference between the estimate and census value for a given area by the census value for that area and multiplying by 100. The end measure simply represents a count of how many evaluation geographies in the summary area exceeded a particular threshold in their absolute percent difference of the estimate. It provides an intuitive measure of the distribution of differences.

Total Absolute Error of Shares = $\sum |((\text{Estimate}/\sum\text{Estimate}) - (\text{Census}/\sum\text{Census}))|$

This measure finds the proportion of each estimate to the total estimate for the summary geography and subtracts the proportion of the census value to the total census value for the summary geography. The absolute value of these proportional differences across evaluation geographies is then summed to the summary geography level. The goal is to provide a measure of the distributional error in the estimated shares.

Table 1. Population Estimates and Census Counts: 1980 to 2010 (Numbers in thousands)

Year	Population Estimate	Census Count	Numeric Difference	Percent Difference
1980	221,672	226,546	-4,874	-2.15
1990	250,172	248,710	1,462	0.59
2000	274,520	281,422	-6,902	-2.45
2010 ADREC	308,450	308,746	-295	-0.10
2010 "Pure" ADREC	307,681	308,746	-1,064	-0.34

Notes:

ADREC refers to Administrative Records-Based estimates.

"Pure" ADREC refers to the ADREC estimates without challenges or Special Censuses.

Negative difference indicates that the estimate is lower than the census count.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 2. Measures of Accuracy for the ADREC Series by Level of Geography: 2000 and 2010			
Level of Geography	Measure	2000	2010
State	MAPE	2.55	1.02
	MALPE	-2.44	-0.41
County	MAPE	3.36	3.10
	MALPE	-1.85	-1.59

Note: ADREC refers to Administrative Records-Based estimates.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 3. Population Estimates and Census Counts by State: 2010								
	ADREC				"Pure" ADREC			
State	Estimate	Census Count	Numeric Difference	Percent Difference	Estimate	Census Count	Numeric Difference	Percent Difference
Alabama	4,724,112	4,779,736	-55,624	-1.16	4,735,614	4,779,736	-44,122	-0.92
Alaska	705,175	710,231	-5,056	-0.71	701,212	710,231	-9,019	-1.27
Arizona	6,654,358	6,392,017	262,341	4.10	6,643,067	6,392,017	251,050	3.93
Arkansas	2,904,540	2,915,918	-11,378	-0.39	2,904,270	2,915,918	-11,648	-0.40
California	37,171,135	37,253,956	-82,821	-0.22	37,270,046	37,253,956	16,090	0.04
Colorado	5,075,295	5,029,196	46,099	0.92	5,082,123	5,029,196	52,927	1.05
Connecticut	3,523,925	3,574,097	-50,172	-1.40	3,541,423	3,574,097	-32,674	-0.91
Delaware	889,722	897,934	-8,212	-0.91	894,136	897,934	-3,798	-0.42
District of Columbia	607,918	601,723	6,195	1.03	585,172	601,723	-16,551	-2.75
Florida	18,636,368	18,801,310	-164,942	-0.88	18,602,475	18,801,310	-198,835	-1.06
Georgia	9,884,534	9,687,653	196,881	2.03	9,784,304	9,687,653	96,651	1.00
Hawaii	1,296,885	1,360,301	-63,416	-4.66	1,303,311	1,360,301	-56,990	-4.19
Idaho	1,555,957	1,567,582	-11,625	-0.74	1,556,415	1,567,582	-11,167	-0.71
Illinois	12,931,584	12,830,632	100,952	0.79	12,935,717	12,830,632	105,085	0.82
Indiana	6,438,366	6,483,802	-45,436	-0.70	6,462,807	6,483,802	-20,995	-0.32
Iowa	3,019,493	3,046,355	-26,862	-0.88	3,026,639	3,046,355	-19,716	-0.65
Kansas	2,835,125	2,853,118	-17,993	-0.63	2,832,043	2,853,118	-21,075	-0.74
Kentucky	4,332,584	4,339,367	-6,783	-0.16	4,331,894	4,339,367	-7,473	-0.17
Louisiana	4,519,356	4,533,372	-14,016	-0.31	4,428,570	4,533,372	-104,802	-2.31
Maine	1,313,697	1,328,361	-14,664	-1.10	1,320,196	1,328,361	-8,165	-0.61
Maryland	5,724,856	5,773,552	-48,696	-0.84	5,709,226	5,773,552	-64,326	-1.11
Massachusetts	6,621,588	6,547,629	73,959	1.13	6,561,765	6,547,629	14,136	0.22
Michigan	9,936,913	9,883,640	53,273	0.54	9,924,365	9,883,640	40,725	0.41
Minnesota	5,283,424	5,303,925	-20,501	-0.39	5,303,976	5,303,925	51	0.00
Mississippi	2,957,749	2,967,297	-9,548	-0.32	2,972,469	2,967,297	5,172	0.17
Missouri	6,004,372	5,988,927	15,445	0.26	5,935,502	5,988,927	-53,425	-0.89
Montana	978,649	989,415	-10,766	-1.09	980,484	989,415	-8,931	-0.90
Nebraska	1,807,012	1,826,341	-19,329	-1.06	1,814,119	1,826,341	-12,222	-0.67
Nevada	2,650,677	2,700,551	-49,874	-1.85	2,661,894	2,700,551	-38,657	-1.43
New Hampshire	1,323,202	1,316,470	6,732	0.51	1,329,774	1,316,470	13,304	1.01
New Jersey	8,723,152	8,791,894	-68,742	-0.78	8,741,739	8,791,894	-50,155	-0.57
New Mexico	2,027,191	2,059,179	-31,988	-1.55	2,037,266	2,059,179	-21,913	-1.06
New York	19,564,202	19,378,102	186,100	0.96	19,058,849	19,378,102	-319,253	-1.65
North Carolina	9,432,921	9,535,483	-102,562	-1.08	9,449,878	9,535,483	-85,605	-0.90
North Dakota	651,787	672,591	-20,804	-3.09	655,026	672,591	-17,565	-2.61
Ohio	11,532,245	11,536,504	-4,259	-0.04	11,477,036	11,536,504	-59,468	-0.52
Oklahoma	3,716,212	3,751,351	-35,139	-0.94	3,727,953	3,751,351	-23,398	-0.62
Oregon	3,847,469	3,831,074	16,395	0.43	3,866,577	3,831,074	35,503	0.93
Pennsylvania	12,625,433	12,702,379	-76,946	-0.61	12,594,256	12,702,379	-108,123	-0.85
Rhode Island	1,056,987	1,052,567	4,420	0.42	1,062,232	1,052,567	9,665	0.92
South Carolina	4,586,078	4,625,364	-39,286	-0.85	4,596,856	4,625,364	-28,508	-0.62
South Dakota	817,760	814,180	3,580	0.44	814,842	814,180	662	0.08
Tennessee	6,326,403	6,346,105	-19,702	-0.31	6,304,764	6,346,105	-41,341	-0.65
Texas	25,101,907	25,145,561	-43,654	-0.17	25,091,487	25,145,561	-54,074	-0.22
Utah	2,818,242	2,763,885	54,357	1.97	2,738,433	2,763,885	-25,452	-0.92
Vermont	622,191	625,741	-3,550	-0.57	625,276	625,741	-465	-0.07
Virginia	7,928,720	8,001,024	-72,304	-0.90	7,926,041	8,001,024	-74,983	-0.94
Washington	6,727,469	6,724,540	2,929	0.04	6,740,957	6,724,540	16,417	0.24
West Virginia	1,824,505	1,852,994	-28,489	-1.54	1,833,541	1,852,994	-19,453	-1.05
Wisconsin	5,664,218	5,686,986	-22,768	-0.40	5,653,766	5,686,986	-33,220	-0.58
Wyoming	546,821	563,626	-16,805	-2.98	549,547	563,626	-14,079	-2.50

Notes:

ADREC refers to Administrative Records-Based estimates.

"Pure" ADREC refers to the ADREC estimates without challenges or Special Censuses.

Negative difference indicates that the Estimate is lower than the Census Count.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 4. Summary of Counties with Challenges or Special Censuses in the 2000s			
		Counties where "Pure" ADREC estimate is closer to census counts than ADREC estimate	
Type of Challenges or Special Census	Number of Counties	Number	Percent
Total	170	96	56
County and Subcounty Challenges	129	73	57
County Challenges	46	26	57
Subcounty Challenges	87	50	57
Special Censuses	44	26	59

Notes:

"Pure" ADREC estimates exclude challenges and Special Censuses.

Four counties had challenges at both the county and subcounty levels.

Three counties had both challenges and Special Censuses.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 5. County Estimates with the Largest Negative and Positive Percent Differences from the Census Counts: 2010					
Series, Measure, and State	County	Estimate	Census Count	Numeric Difference	Percent Difference
ADREC					
Largest Negative Percent Differences					
Texas	Loving County	57	82	-25	-30.49
Texas	Garza County	4,704	6,461	-1,757	-27.19
Alaska	North Slope Borough	6,900	9,430	-2,530	-26.83
Montana	Liberty County	1,752	2,339	-587	-25.10
Georgia	Stewart County	4,584	6,058	-1,474	-24.33
Nebraska	Arthur County	353	460	-107	-23.26
Georgia	Webster County	2,167	2,799	-632	-22.58
Nevada	Esmeralda County	607	783	-176	-22.48
Georgia	Dooly County	11,595	14,918	-3,323	-22.28
Georgia	Telfair County	12,849	16,500	-3,651	-22.13
Largest Positive Percent Differences					
Georgia	Chattahoochee County	13,021	11,267	1,754	15.57
Virginia	Accomack County	38,453	33,164	5,289	15.95
Colorado	Saguache County	7,101	6,108	993	16.26
Kansas	Finney County	42,904	36,776	6,128	16.66
Texas	McMullen County	831	707	124	17.54
Louisiana	St. Bernard Parish	42,692	35,897	6,795	18.93
Montana	Golden Valley County	1,072	884	188	21.27
Georgia	Lee County	34,731	28,298	6,433	22.73
Colorado	Mineral County	913	712	201	28.23
Hawaii	Kalawao County	131	90	41	45.56
"Pure" ADREC					
Largest Negative Percent Differences					
Texas	Loving County	57	82	-25	-30.49
Texas	Garza County	4,727	6,461	-1,734	-26.84
Alaska	North Slope Borough	6,934	9,430	-2,496	-26.47
Montana	Liberty County	1,759	2,339	-580	-24.80
Georgia	Stewart County	4,607	6,058	-1,451	-23.95
Nebraska	Arthur County	355	460	-105	-22.83
Georgia	Webster County	2,177	2,799	-622	-22.22
Nevada	Esmeralda County	610	783	-173	-22.09
Georgia	Dooly County	11,652	14,918	-3,266	-21.89
Georgia	Telfair County	12,913	16,500	-3,587	-21.74
Largest Positive Percent Differences					
Georgia	Lee County	32,254	25,821	6,433	13.98
Mississippi	Jefferson County	8,904	7,726	1,178	15.25
South Dakota	Dewey County	6,110	5,301	809	15.26
Georgia	Chattahoochee County	13,088	11,267	1,821	16.16
Virginia	Accomack County	38,643	33,164	5,479	16.52
Colorado	Saguache County	7,136	6,108	1,028	16.83
Texas	McMullen County	835	707	128	18.10
Montana	Golden Valley County	1,077	884	193	21.83
Colorado	Mineral County	918	712	206	28.93
Hawaii	Kalawao County	131	90	41	45.56

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 6. Measures of Accuracy at the National Level - Evaluation of County-Level Estimates: 2010						
Series	MAPE	MALPE	Percent Difference ±5%	Percent Difference ±10%	Total Absolute Error of Shares	Root Mean Squared Error
ADREC	3.10	-1.59	558	110	0.0202	7,739
"Pure" ADREC	2.91	-1.28	504	103	0.0181	7,192

Notes:

The Total Absolute Error of Shares is a measurement of the error in the estimated distribution.

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Percent Difference columns show the number of counties.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 7. Measures of Accuracy by County Population Size: 2010

Population Size	Series	Number of Counties	MAPE	MALPE	Percent Difference ±5%		Percent Difference ±10%		Root Mean Squared Error
					Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	
<5,000	ADREC	294	6.36	-4.15	151	51.36	49	16.67	240
	"Pure" ADREC		6.11	-3.69	146	49.66	46	15.65	232
5,000 to 9,999	ADREC	404	4.19	-2.68	119	29.46	29	7.18	447
	"Pure" ADREC		3.95	-2.25	104	25.74	26	6.44	428
10,000 to 19,999	ADREC	652	3.26	-1.76	118	18.10	20	3.07	698
	"Pure" ADREC		3.07	-1.29	112	17.18	20	3.07	667
20,000 to 64,999	ADREC	1,047	2.53	-1.20	129	12.32	8	0.76	1,457
	"Pure" ADREC		2.38	-0.82	113	10.79	8	0.76	1,401
65,000 to 99,999	ADREC	222	2.07	-0.52	14	6.31	2	0.90	2,558
	"Pure" ADREC		1.94	-0.47	14	6.31	2	0.90	2,433
100,000 to 249,999	ADREC	292	1.82	-0.68	14	4.79	0	0.00	4,510
	"Pure" ADREC		1.65	-0.44	12	4.11	0	0.00	4,254
250,000 to 499,999	ADREC	120	1.72	-0.18	5	4.17	1	0.83	9,552
	"Pure" ADREC		1.47	-0.51	2	1.67	1	0.83	8,546
500,000 +	ADREC	112	1.87	0.49	8	7.14	1	0.89	38,642
	"Pure" ADREC		1.50	-0.19	1	0.89	0	0.00	35,951

Notes:

Population size is based on Census 2000 population.

The percent of counties with percent differences of ± 5% and ±10% is calculated by dividing the number of outliers by the number of counties in each size category.

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 8. Measures of Accuracy by County Percent Change: 2010									
					Percent Difference ±5%		Percent Difference ±10%		
Percent Change	Series	Number of Counties	MAPE	MALPE	Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	Root Mean Squared Error
<= -10	ADREC	215	4.85	-0.32	77	36	21	10	6,303
	"Pure" ADREC		4.79	-0.11	76	35	23	11	4,517
-9.9 to -0.1	ADREC	889	2.81	-1.45	137	15	21	2	4,542
	"Pure" ADREC		2.62	-1.04	119	13	17	2	3,720
0 to 9.9	ADREC	1,231	2.78	-1.59	188	15	24	2	6,825
	"Pure" ADREC		2.55	-1.29	158	13	20	2	6,386
10 to 24.9	ADREC	586	3.26	-2.02	103	18	24	4	12,405
	"Pure" ADREC		3.06	-1.79	98	17	24	4	12,021
25 to 49.9	ADREC	187	3.98	-2.30	44	24	18	10	8,038
	"Pure" ADREC		3.88	-2.03	43	23	17	9	6,955
50+	ADREC	35	3.59	-1.53	9	26	2	6	7,070
	"Pure" ADREC		3.65	-1.38	10	29	2	6	7,437

Notes:

Percent change is calculated as the change from 2000 to 2010

The percent of counties with percent differences of ±5% and ±10% is calculated by dividing the number of outliers by the number of counties in each size category.

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 9. Measures of Accuracy by County Population Size and Percent Change: 2010

Population Size	Percent Change	Series	Number of Counties	MAPE	MALPE	Percent Difference ±5%		Percent Difference ±10%		Root Mean Squared Error
						Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	
0 to 9,999	<= -10	ADREC	164	4.85	-1.40	57	35	15	9	182
		"Pure" ADREC		4.69	-0.92	55	34	15	9	181
	-9.9 to -0.1	ADREC	286	4.17	-2.95	92	32	18	6	281
		"Pure" ADREC		3.94	-2.49	79	28	16	6	267
	0 to 9.9	ADREC	166	5.34	-3.81	74	45	19	11	378
		"Pure" ADREC		5.04	-3.45	71	43	16	10	354
	10 to 24.9	ADREC	66	7.18	-5.79	32	48	15	23	572
		"Pure" ADREC		6.89	-5.33	31	47	15	23	555
	25 to 49.9	ADREC	13	13.95	-13.95	12	92	10	77	1,263
		"Pure" ADREC		13.54	-13.54	11	85	9	69	1,235
	50+	ADREC	3	10.64	-10.64	3	100	1	33	1,055
		"Pure" ADREC		10.19	-10.19	3	100	1	33	1,014
10,000 to 19,999	<= -10	ADREC	32	4.26	2.87	9	28	4	13	752
		"Pure" ADREC		4.46	3.37	11	34	5	16	787
	-9.9 to -0.1	ADREC	250	2.54	-1.10	26	10	0	0	441
		"Pure" ADREC		2.38	-0.61	25	10	0	0	425
	0 to 9.9	ADREC	263	3.11	-2.08	46	17	4	2	637
		"Pure" ADREC		2.84	-1.64	40	15	3	1	590
	10 to 24.9	ADREC	87	4.47	-3.26	28	32	6	7	1,005
		"Pure" ADREC		4.25	-2.78	28	32	6	7	961
	25 to 49.9	ADREC	19	7.57	-6.69	8	42	6	32	1,687
		"Pure" ADREC		7.38	-6.22	7	37	6	32	1,645
	50+	ADREC	1	6.36	-6.36	1	100	0	0	1,497
		"Pure" ADREC		5.89	-5.89	1	100	0	0	1,387
20,000 to 64,999	<= -10	ADREC	16	5.10	2.50	9	56	1	6	2,015
		"Pure" ADREC		5.31	3.01	8	50	1	6	2,114
	-9.9 to -0.1	ADREC	255	2.01	-0.70	15	6	1	0	945
		"Pure" ADREC		1.84	-0.28	13	5	0	0	843
	0 to 9.9	ADREC	504	2.35	-1.34	51	10	1	0	1,150
		"Pure" ADREC		2.15	-0.89	39	8	1	0	1,069
	10 to 24.9	ADREC	198	3.13	-1.86	35	18	2	1	1,798
		"Pure" ADREC		2.98	-1.69	32	16	3	2	1,777
	25 to 49.9	ADREC	63	3.24	-0.88	14	22	2	3	2,020
		"Pure" ADREC		3.35	-0.69	16	25	2	3	2,074
	50+	ADREC	11	5.05	-1.55	5	45	1	9	5,774
		"Pure" ADREC		5.13	-1.17	5	45	1	9	5,495
65,000 +	<= -10	ADREC	3	10.01	10.01	2	67	1	33	53,083
		"Pure" ADREC		11.42	-9.90	2	67	2	67	37,819
	-9.9 to -0.1	ADREC	98	1.67	0.06	4	4	2	2	13,568
		"Pure" ADREC		1.37	0.11	2	2	1	1	11,090
	0 to 9.9	ADREC	298	1.80	-0.35	17	6	0	0	13,774
		"Pure" ADREC		1.59	-0.44	8	3	0	0	12,891
	10 to 24.9	ADREC	235	1.83	-0.62	8	3	1	0	19,507
		"Pure" ADREC		1.61	-0.52	7	3	0	0	18,901
	25 to 49.9	ADREC	92	2.33	-0.72	10	11	0	0	11,302
		"Pure" ADREC		2.16	-0.47	9	10	0	0	9,726
	50+	ADREC	20	1.59	0.09	0	0	0	0	8,298
		"Pure" ADREC		1.74	0.05	1	5	0	0	8,940

Notes:

Population size is based on Census 2000 population.

Percent change is calculated as the change from 2000 to 2010.

The percent of counties with percent differences of ±5% and ±10% is calculated by dividing the number of outliers by the number of counties in each size category

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 10. Population Estimates and Census Counts: 2010				
Series	Estimate	2010 Census Count	Numeric Difference	Percent Difference
ADREC	308,450,484	308,745,538	-295,054	-0.10
"Pure" ADREC	307,681,330	308,745,538	-1,064,208	-0.34
ACS 5-Year	295,580,381	308,745,538	-13,165,157	-4.26
ACS 5-Year - ADREC State Control	308,450,484	308,745,538	-295,054	-0.10
Census 2000 HU-based	316,007,664	308,745,538	7,262,126	2.35

Notes:

ADREC refers to Administrative Records-Based estimates.

"Pure" ADREC refers to the ADREC estimates without challenges or Special Censuses.

Negative difference indicates that the estimate is lower than the census count.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 11. Measures of Accuracy at the National Level - Evaluation of County-Level Estimates: 2010						
Series	MAPE	MALPE	Percent Difference ±5%	Percent Difference ±10%	Total Absolute Error of Shares	Root Mean Squared Error
ADREC	3.10	-1.59	558	110	0.0202	7,739
"Pure" ADREC	2.91	-1.28	504	103	0.0181	7,192
ACS 5-Year	5.80	-2.81	1,365	518	0.0306	19,676
ACS 5-Year - ADREC State Control	5.17	0.58	1,204	414	0.0271	7,925
Census 2000 HU-based	6.38	4.71	1,584	608	0.0321	13,173

Notes:

ADREC refers to Administrative Records-Based estimates.

"Pure" ADREC refers to the ADREC estimates without challenges or Special Censuses.

Percent Difference columns show the number of counties.

The Total Absolute Error of Shares is a measurement of the error in the estimated distribution.

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 12. Measures of Accuracy for Selected Series by County Population Size and Percent Change: 2010

Population Size	Percent Change	Series	Number of Counties	MAPE	MALPE	Percent Difference ±5%		Percent Difference ±10%		Root Mean Squared Error
						Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	
0 to 9,999	<= -10	"Pure" ADREC	164	4.69	-0.92	55	34	15	9	181
		ACS 5-Year		9.03	6.47	104	63	55	34	425
		ACS 5-Year - ADREC State Control		10.65	9.13	114	70	66	40	512
		Census 2000 HU-based		19.85	19.85	164	100	164	100	797
	-9.9 to -0.1	"Pure" ADREC	286	3.94	-2.49	79	28	16	6	267
		ACS 5-Year		6.17	-0.60	139	49	60	21	459
		ACS 5-Year - ADREC State Control		6.38	2.24	141	49	57	20	478
		Census 2000 HU-based		8.68	8.68	232	81	101	35	591
	0 to 9.9	"Pure" ADREC	166	5.04	-3.45	71	43	16	10	354
		ACS 5-Year		8.59	-5.99	108	65	53	32	634
		ACS 5-Year - ADREC State Control		7.44	-1.89	101	61	39	23	555
		Census 2000 HU-based		3.89	1.97	43	26	9	5	360
	10 to 24.9	"Pure" ADREC	66	6.89	-5.33	31	47	15	23	555
		ACS 5-Year		12.67	-8.77	52	79	38	58	1,264
		ACS 5-Year - ADREC State Control		11.10	-4.05	48	73	31	47	1,121
		Census 2000 HU-based		7.87	-1.60	47	71	26	39	696
	25 to 49.9	"Pure" ADREC	13	13.54	-13.54	11	85	9	69	1,235
		ACS 5-Year		19.85	-18.52	10	77	9	69	1,645
		ACS 5-Year - ADREC State Control		16.50	-13.98	11	85	8	62	1,322
		Census 2000 HU-based		12.67	-11.83	12	92	7	54	987
	50+	"Pure" ADREC	3	10.19	-10.19	3	100	1	33	1,014
		ACS 5-Year		15.78	-12.87	2	67	1	33	2,086
		ACS 5-Year - ADREC State Control		14.81	-10.59	3	100	1	33	1,936
		Census 2000 HU-based		13.17	-4.66	2	67	2	67	1,589
10,000 to 19,999	<= -10	"Pure" ADREC	32	4.46	3.37	11	34	5	16	787
		ACS 5-Year		8.58	4.81	24	75	10	31	1,117
		ACS 5-Year - ADREC State Control		9.97	8.05	23	72	16	50	1,344
		Census 2000 HU-based		20.02	20.02	32	100	32	100	2,396
	-9.9 to -0.1	"Pure" ADREC	250	2.38	-0.61	25	10	0	0	425
		ACS 5-Year		4.85	-0.46	100	40	29	12	842
		ACS 5-Year - ADREC State Control		5.14	2.19	111	44	27	11	888
		Census 2000 HU-based		8.91	8.91	221	88	88	35	1,311
	0 to 9.9	"Pure" ADREC	263	2.84	-1.64	40	15	3	1	590
		ACS 5-Year		5.78	-3.73	125	48	39	15	1,153
		ACS 5-Year - ADREC State Control		5.08	-0.32	113	43	32	12	1,029
		Census 2000 HU-based		3.86	2.87	72	27	17	6	828
	10 to 24.9	"Pure" ADREC	87	4.25	-2.78	28	32	6	7	961
		ACS 5-Year		9.61	-8.96	61	70	36	41	2,011
		ACS 5-Year - ADREC State Control		7.28	-4.69	63	72	39	45	2,157
		Census 2000 HU-based		6.13	-0.46	50	57	13	15	1,414
	25 to 49.9	"Pure" ADREC	19	7.38	-6.22	7	37	6	32	1,645
		ACS 5-Year		13.34	-11.96	13	68	9	47	2,705
		ACS 5-Year - ADREC State Control		11.79	-7.45	13	68	9	47	2,349
		Census 2000 HU-based		8.24	-6.48	11	58	6	32	1,695
	50+	"Pure" ADREC	1	5.89	-5.89	1	100	0	0	1,387
		ACS 5-Year		7.33	-7.33	1	100	0	0	1,725
		ACS 5-Year - ADREC State Control		0.73	-0.73	0	0	0	0	172
		Census 2000 HU-based		2.85	-2.85	0	0	0	0	670

Population Size	Percent Change	Series	Number of Counties	MAPE	MALPE	Percent Difference ±5%		Percent Difference ±10%		Root Mean Squared Error
						Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	
20,000 to 64,999	<= -10	"Pure" ADREC	16	5.31	3.01	8	50	1	6	2,114
		ACS 5-Year		5.32	-0.17	8	50	1	6	2,023
		ACS 5-Year - ADREC State Control		5.80	2.88	10	63	3	19	2,569
		Census 2000 HU-based		19.25	19.10	15	94	15	94	6,584
	-9.9 to -0.1	"Pure" ADREC	255	1.84	-0.28	13	5	0	0	843
		ACS 5-Year		3.28	-0.25	51	20	10	4	1,386
		ACS 5-Year - ADREC State Control		4.00	2.54	77	30	13	5	1,597
		Census 2000 HU-based		7.70	7.69	203	80	51	20	2,679
	0 to 9.9	"Pure" ADREC	504	2.15	-0.89	39	8	1	0	1,069
		ACS 5-Year		4.51	-2.91	179	36	39	8	2,103
		ACS 5-Year - ADREC State Control		3.76	0.22	140	28	24	5	1,767
		Census 2000 HU-based		3.91	3.23	157	31	19	4	1,849
	10 to 24.9	"Pure" ADREC	198	2.98	-1.69	32	16	3	2	1,777
		ACS 5-Year		6.99	-6.14	113	57	59	30	3,997
		ACS 5-Year - ADREC State Control		5.24	-2.30	85	43	27	14	3,065
		Census 2000 HU-based		4.37	-0.33	72	36	10	5	2,477
	25 to 49.9	"Pure" ADREC	63	3.35	-0.69	16	25	2	3	2,074
		ACS 5-Year		6.87	-5.73	34	54	15	24	4,964
		ACS 5-Year - ADREC State Control		6.17	-1.44	31	49	13	21	4,166
		Census 2000 HU-based		5.08	-1.16	23	37	10	16	3,559
	50+	"Pure" ADREC	11	5.13	-1.17	5	45	1	9	5,495
		ACS 5-Year		13.91	-12.64	9	82	6	55	12,182
		ACS 5-Year - ADREC State Control		11.28	-8.40	7	64	6	55	10,377
		Census 2000 HU-based		11.29	-7.71	7	64	5	45	11,195
65,000 +	<= -10	"Pure" ADREC	3	11.42	-9.90	2	67	2	67	37,819
		ACS 5-Year		6.41	-6.13	1	33	1	33	39,904
		ACS 5-Year - ADREC State Control		6.08	-2.73	2	67	1	33	25,821
		Census 2000 HU-based		14.53	14.53	3	100	2	67	153,480
	-9.9 to -0.1	"Pure" ADREC	98	1.37	0.11	2	2	1	1	11,090
		ACS 5-Year		2.47	-0.75	7	7	3	3	19,958
		ACS 5-Year - ADREC State Control		3.39	2.20	24	24	4	4	9,239
		Census 2000 HU-based		7.02	7.02	72	73	11	11	49,015
	0 to 9.9	"Pure" ADREC	298	1.59	-0.44	8	3	0	0	12,891
		ACS 5-Year		3.77	-3.16	77	26	11	4	48,889
		ACS 5-Year - ADREC State Control		2.46	0.32	36	12	5	2	14,434
		Census 2000 HU-based		3.41	3.09	76	26	8	3	17,621
	10 to 24.9	"Pure" ADREC	235	1.61	-0.52	7	3	0	0	18,901
		ACS 5-Year		4.72	-4.30	92	39	20	9	38,045
		ACS 5-Year - ADREC State Control		2.85	-0.26	38	16	4	2	20,162
		Census 2000 HU-based		2.96	1.27	40	17	6	3	18,436
	25 to 49.9	"Pure" ADREC	92	2.16	-0.47	9	10	0	0	9,726
		ACS 5-Year		5.47	-5.28	45	49	8	9	29,950
		ACS 5-Year - ADREC State Control		2.92	-0.80	18	20	2	2	11,481
		Census 2000 HU-based		3.12	-0.22	21	23	4	4	20,763
	50+	"Pure" ADREC	20	1.74	0.05	1	5	0	0	8,940
		ACS 5-Year		7.04	-6.69	10	50	6	30	37,141
		ACS 5-Year - ADREC State Control		4.20	-1.17	6	30	2	10	21,997
		Census 2000 HU-based		5.13	-3.18	9	45	2	10	30,237

Notes:

Population size is based on Census 2000 population.

Percent change is calculated as the change from 2000 to 2010.

The percent of counties with percent differences of ±5% and ±10% is calculated by dividing the number of outliers by the number of counties in each size category

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Table 13. Measures of Accuracy for ACS Series by County Population Size and Percent Change: 201(										
						Percent Differences ±5%		Percent Differences ±10%		
Population Size	Percent Change	Series	Number of Counties	MAPE	MALPE	Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	Root Mean Squared Error
0 to 9,999	<= -10	"Pure" ADREC	164	4.69	-0.92	55	34	15	9	181
		ACS 1-Year		13.40	3.74	126	77	83	51	580
		ACS 3-Year		9.68	4.42	100	61	60	37	438
		ACS 5-Year		9.03	6.47	104	63	55	34	425
	-9.9 to -0.1	"Pure" ADREC	286	3.94	-2.49	79	28	16	6	267
		ACS 1-Year		11.17	-2.06	196	69	124	43	762
		ACS 3-Year		7.61	-1.74	154	54	78	27	567
		ACS 5-Year		6.17	-0.60	139	49	60	21	459
	0 to 9.9	"Pure" ADREC	166	5.04	-3.45	71	43	16	10	354
		ACS 1-Year		12.30	-7.65	121	73	84	51	890
		ACS 3-Year		10.17	-7.21	119	72	64	39	732
		ACS 5-Year		8.59	-5.99	108	65	53	32	634
	10 to 24.9	"Pure" ADREC	66	6.89	-5.33	31	47	15	23	555
		ACS 1-Year		18.58	-7.94	59	89	44	67	1,659
		ACS 3-Year		14.17	-9.75	55	83	42	64	1,379
		ACS 5-Year		12.67	-8.77	52	79	38	58	1,264
	25 to 49.9	"Pure" ADREC	13	13.54	-13.54	11	85	9	69	1,235
		ACS 1-Year		19.82	-17.71	12	92	9	69	1,609
		ACS 3-Year		19.46	-17.76	11	85	10	77	1,701
		ACS 5-Year		19.85	-18.52	10	77	9	69	1,645
	50+	"Pure" ADREC	3	10.19	-10.19	3	100	1	33	1,014
		ACS 1-Year		13.25	-11.51	2	67	1	33	1,693
		ACS 3-Year		13.73	-9.82	3	100	1	33	1,678
		ACS 5-Year		15.78	-12.87	2	67	1	33	2,086
10,000 to 19,999	<= -10	"Pure" ADREC	32	4.46	3.37	11	34	5	16	787
		ACS 1-Year		10.18	3.20	18	56	15	47	1,652
		ACS 3-Year		9.43	3.82	22	69	14	44	1,297
		ACS 5-Year		8.58	4.81	24	75	10	31	1,117
	-9.9 to -0.1	"Pure" ADREC	250	2.38	-0.61	25	10	0	0	425
		ACS 1-Year		8.26	-1.73	150	60	80	32	1,396
		ACS 3-Year		5.99	-1.39	124	50	52	21	1,035
		ACS 5-Year		4.85	-0.46	100	40	29	12	842
	0 to 9.9	"Pure" ADREC	263	2.84	-1.64	40	15	3	1	590
		ACS 1-Year		8.27	-4.27	169	64	84	32	1,595
		ACS 3-Year		6.52	-4.15	139	53	53	20	1,285
		ACS 5-Year		5.78	-3.73	125	48	39	15	1,153
	10 to 24.9	"Pure" ADREC	87	4.25	-2.78	28	32	6	7	961
		ACS 1-Year		12.10	-10.75	64	74	47	54	2,544
		ACS 3-Year		10.34	-9.70	62	71	42	48	2,195
		ACS 5-Year		9.61	-8.96	61	70	36	41	2,011
	25 to 49.9	"Pure" ADREC	19	7.38	-6.22	7	37	6	32	1,645
		ACS 1-Year		13.54	-10.77	13	68	9	47	2,806
		ACS 3-Year		13.44	-11.55	14	74	8	42	2,694
		ACS 5-Year		13.34	-11.96	13	68	9	47	2,705
	50+	"Pure" ADREC	1	5.89	-5.89	1	100	0	0	1,387
		ACS 1-Year		2.93	-2.93	0	0	0	0	689
		ACS 3-Year		6.40	-6.40	1	100	0	0	1,507
		ACS 5-Year		7.33	-7.33	1	100	0	0	1,725

Population Size	Percent Change	Series	Number of Counties	MAPE	MALPE	Percent Differences ±5%		Percent Differences ±10%		Root Mean Squared Error
						Number of Counties	Percent of Counties	Number of Counties	Percent of Counties	
20,000 to 64,999	<= -10	"Pure" ADREC	16	5.31	3.01	8	50	1	6	2,114
		ACS 1-Year		5.55	-2.15	8	50	2	13	1,993
		ACS 3-Year		5.65	-1.88	9	56	2	13	1,954
		ACS 5-Year		5.32	-0.17	8	50	1	6	2,023
	-9.9 to -0.1	"Pure" ADREC	255	1.84	-0.28	13	5	0	0	843
		ACS 1-Year		5.48	-1.20	103	40	41	16	2,238
		ACS 3-Year		3.91	-0.99	72	28	16	6	1,625
		ACS 5-Year		3.28	-0.25	51	20	10	4	1,386
	0 to 9.9	"Pure" ADREC	504	2.15	-0.89	39	8	1	0	1,069
		ACS 1-Year		6.31	-3.64	257	51	107	21	2,841
		ACS 3-Year		5.03	-3.40	211	42	54	11	2,352
		ACS 5-Year		4.51	-2.91	179	36	39	8	2,103
	10 to 24.9	"Pure" ADREC	198	2.98	-1.69	32	16	3	2	1,777
		ACS 1-Year		8.45	-6.71	127	64	66	33	4,630
		ACS 3-Year		7.65	-6.66	122	62	62	31	4,299
		ACS 5-Year		6.99	-6.14	113	57	59	30	3,997
	25 to 49.9	"Pure" ADREC	63	3.35	-0.69	16	25	2	3	2,074
		ACS 1-Year		7.76	-5.96	36	57	17	27	5,276
		ACS 3-Year		6.59	-5.82	32	51	16	25	4,802
		ACS 5-Year		6.87	-5.73	34	54	15	24	4,964
	50+	"Pure" ADREC	11	5.13	-1.17	5	45	1	9	5,495
		ACS 1-Year		14.59	-14.59	9	82	7	64	12,330
		ACS 3-Year		14.69	-13.84	9	82	6	55	12,667
		ACS 5-Year		13.91	-12.64	9	82	6	55	12,182
65,000+	<= -10	"Pure" ADREC	3	11.42	-9.90	2	67	2	67	37,819
		ACS 1-Year		6.50	-5.62	1	33	1	33	56,162
		ACS 3-Year		8.90	-8.90	2	67	1	33	51,913
		ACS 5-Year		6.41	-6.13	1	33	1	33	39,904
	-9.9 to -0.1	"Pure" ADREC	98	1.37	0.11	2	2	1	1	11,090
		ACS 1-Year		3.87	-1.65	20	20	5	5	27,814
		ACS 3-Year		2.89	-1.53	14	14	4	4	24,716
		ACS 5-Year		2.47	-0.75	7	7	3	3	19,958
	0 to 9.9	"Pure" ADREC	298	1.59	-0.44	8	3	0	0	12,891
		ACS 1-Year		4.37	-3.57	109	37	16	5	47,546
		ACS 3-Year		4.07	-3.53	94	32	15	5	51,951
		ACS 5-Year		3.77	-3.16	77	26	11	4	48,889
	10 to 24.9	"Pure" ADREC	235	1.61	-0.52	7	3	0	0	18,901
		ACS 1-Year		5.21	-4.63	99	42	25	11	42,323
		ACS 3-Year		5.08	-4.68	101	43	24	10	41,966
		ACS 5-Year		4.72	-4.30	92	39	20	9	38,045
	25 to 49.9	"Pure" ADREC	92	2.16	-0.47	9	10	0	0	9,726
		ACS 1-Year		6.22	-6.02	48	52	23	25	36,830
		ACS 3-Year		5.93	-5.79	48	52	15	16	34,408
		ACS 5-Year		5.47	-5.28	45	49	8	9	29,950
	50+	"Pure" ADREC	20	1.74	0.05	1	5	0	0	8,940
		ACS 1-Year		7.73	-7.73	14	70	6	30	37,287
		ACS 3-Year		6.73	-6.70	10	50	6	30	36,718
		ACS 5-Year		7.04	-6.69	10	50	6	30	37,141

Notes:

Population size is based on Census 2000 population.

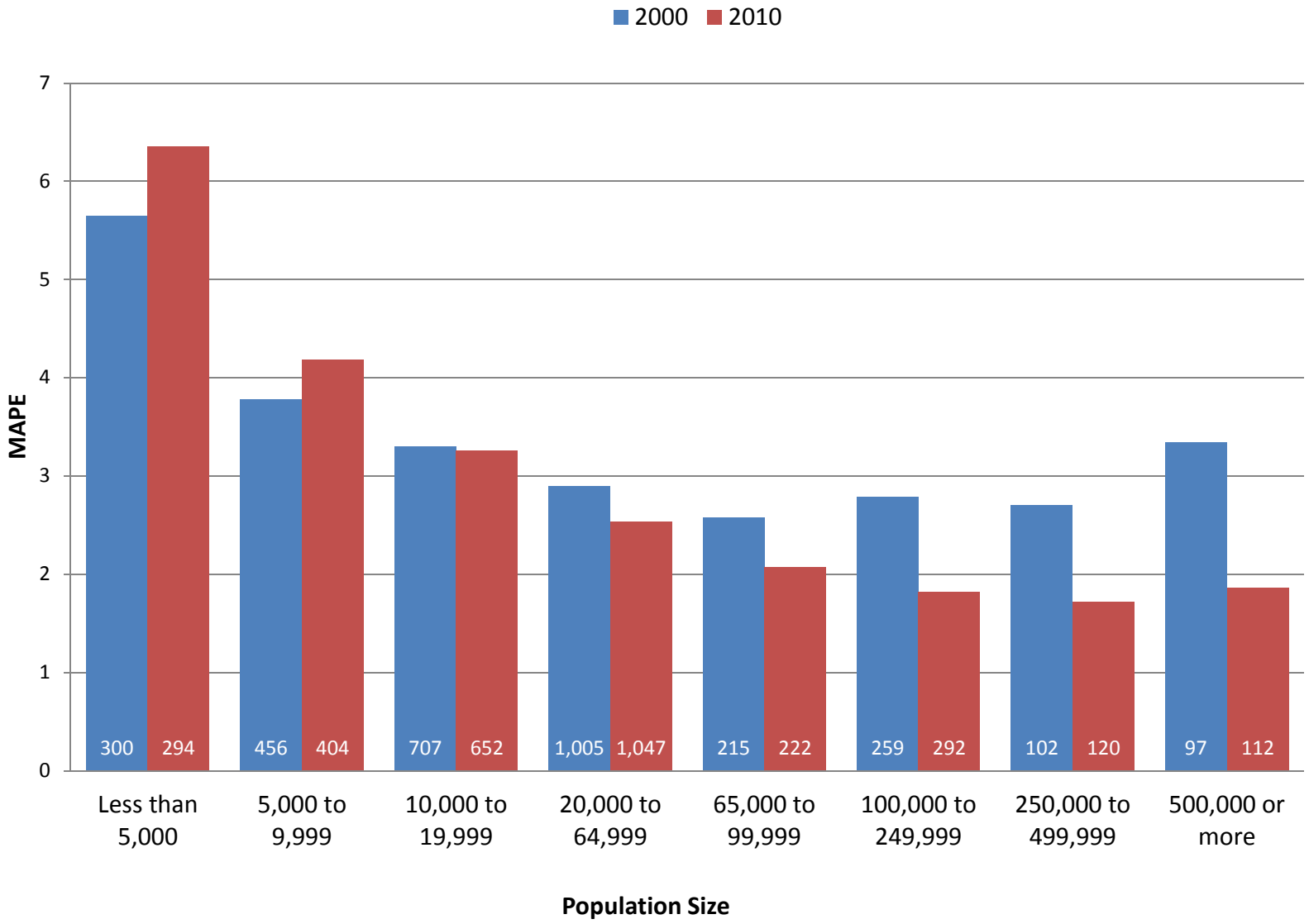
Percent change is calculated as the change from 2000 to 2010.

The percent of counties with percent differences of ±5% and ±10% is calculated by dividing the number of outliers by the number of counties in each size category.

The Root Mean Squared Error is a measurement of the difference from the census count in terms of people.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

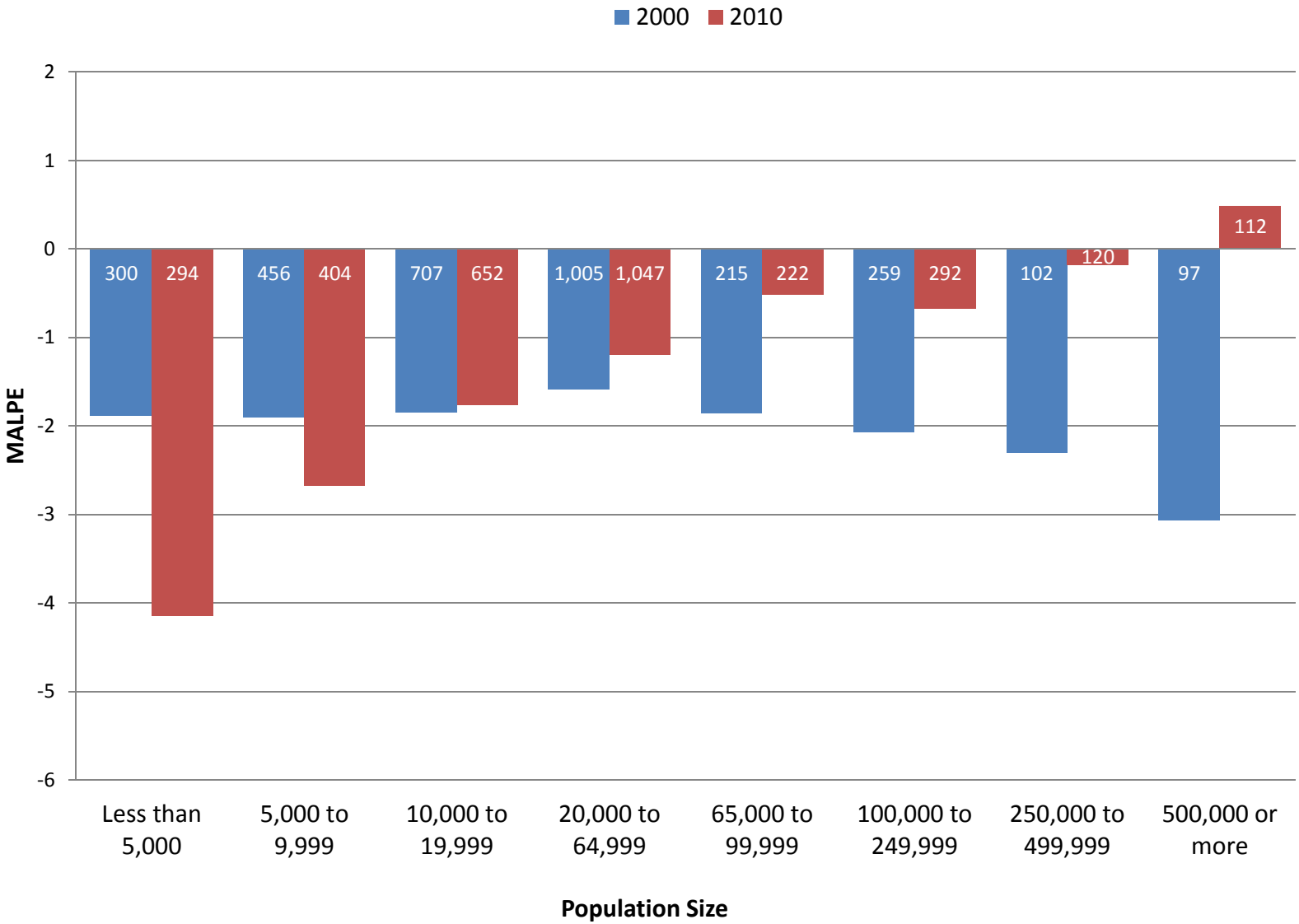
Figure 1. MAPEs for the ADREC Series by County Population Size: 2000 and 2010



Notes: The number of counties in each category is at the x axis for each series.
Size categories for 2000 are based on 1990 Census population, 2010 are based on 2000.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

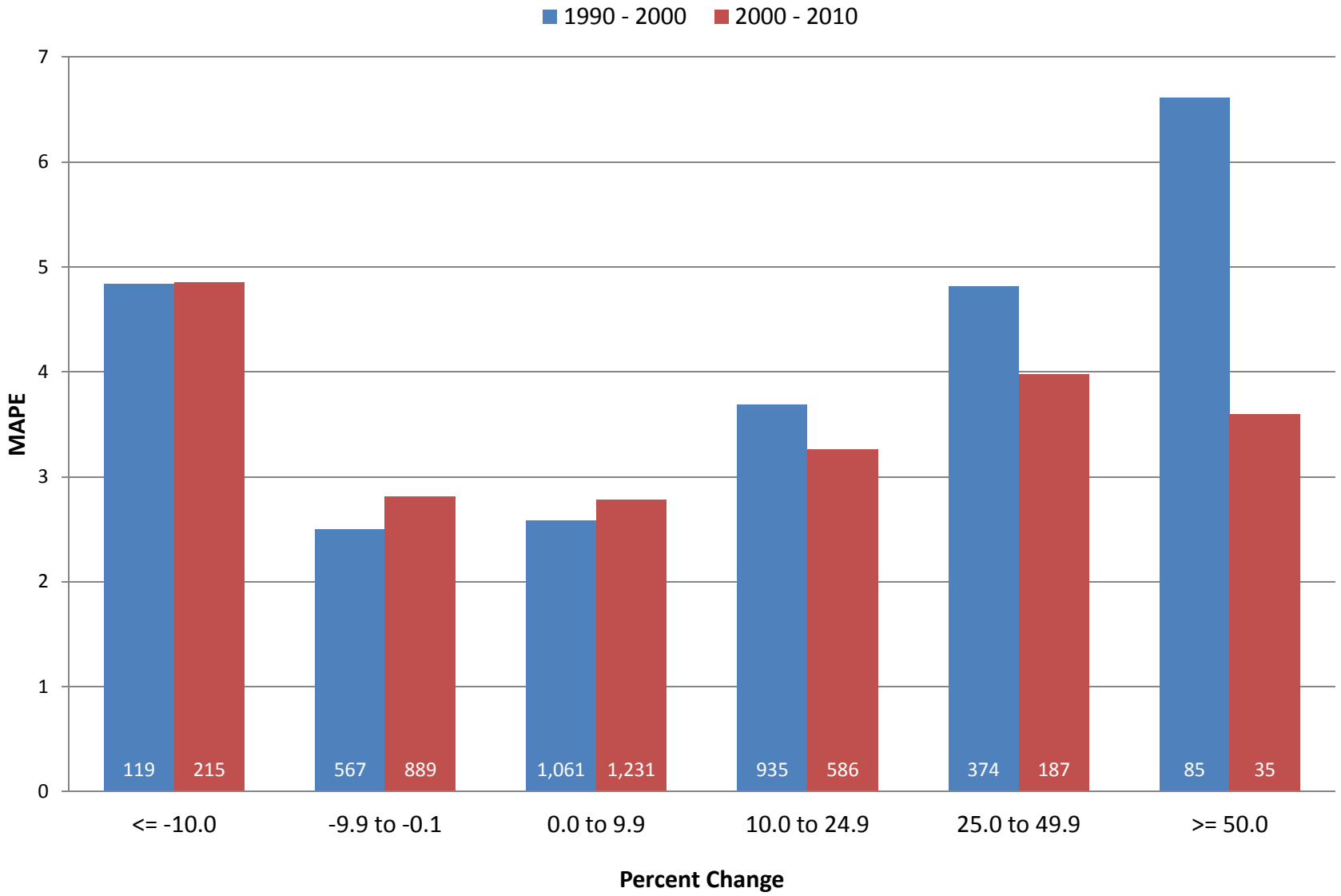
Figure 2. MALPEs for the ADREC Series by County Population Size: 2000 and 2010



Notes: The number of counties in each category is at the x axis for each series.
Size categories for 2000 are based on 1990 Census population, 2010 are based on 2000.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

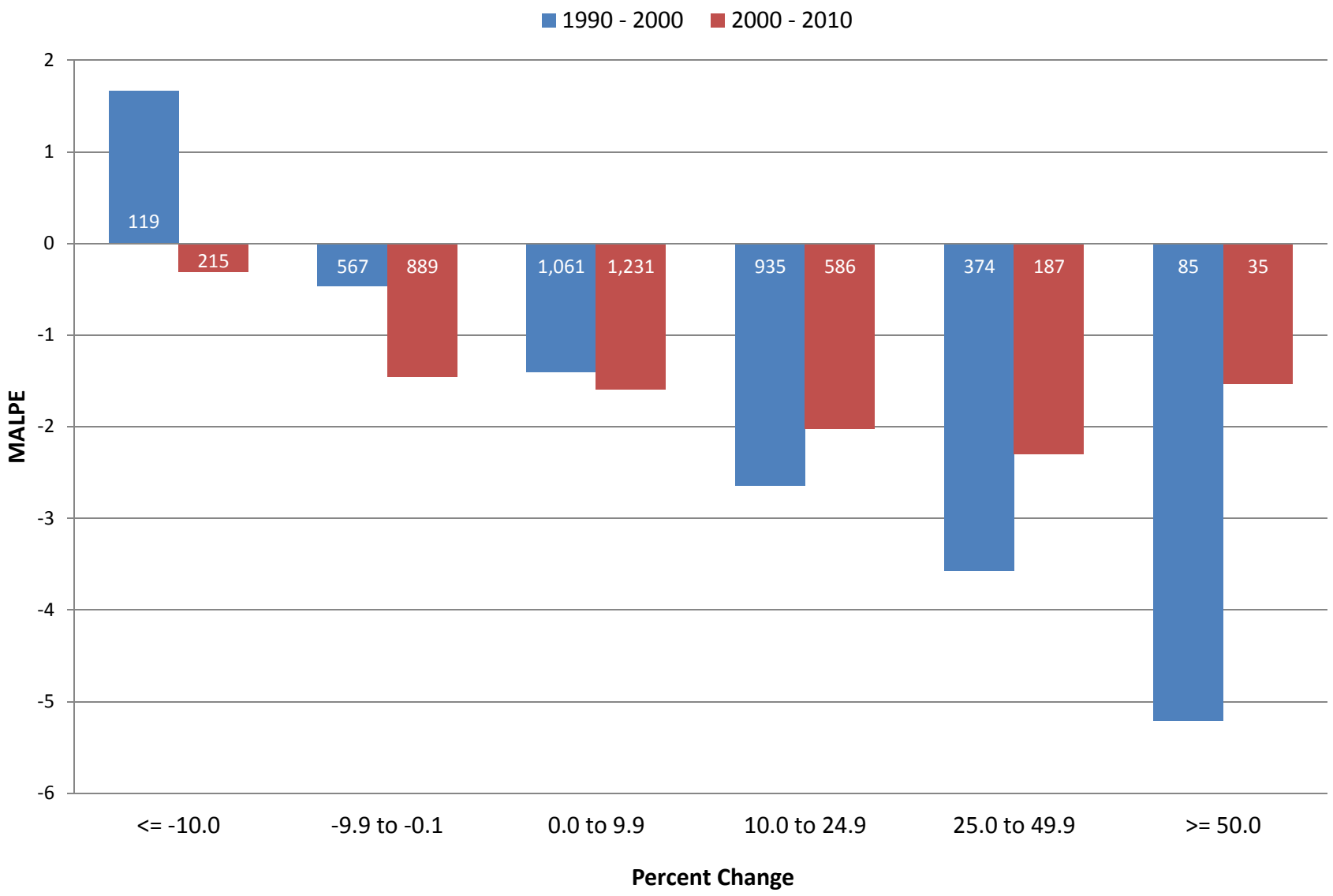
Figure 3. MAPEs for the ADREC Series by County Percent Change: 1990 - 2000 and 2000 - 2010



Notes: The number of counties in each category is at the x axis for each series.
Percent change is calculated as the change from 1990 to 2000 and from 2000 to 2010.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

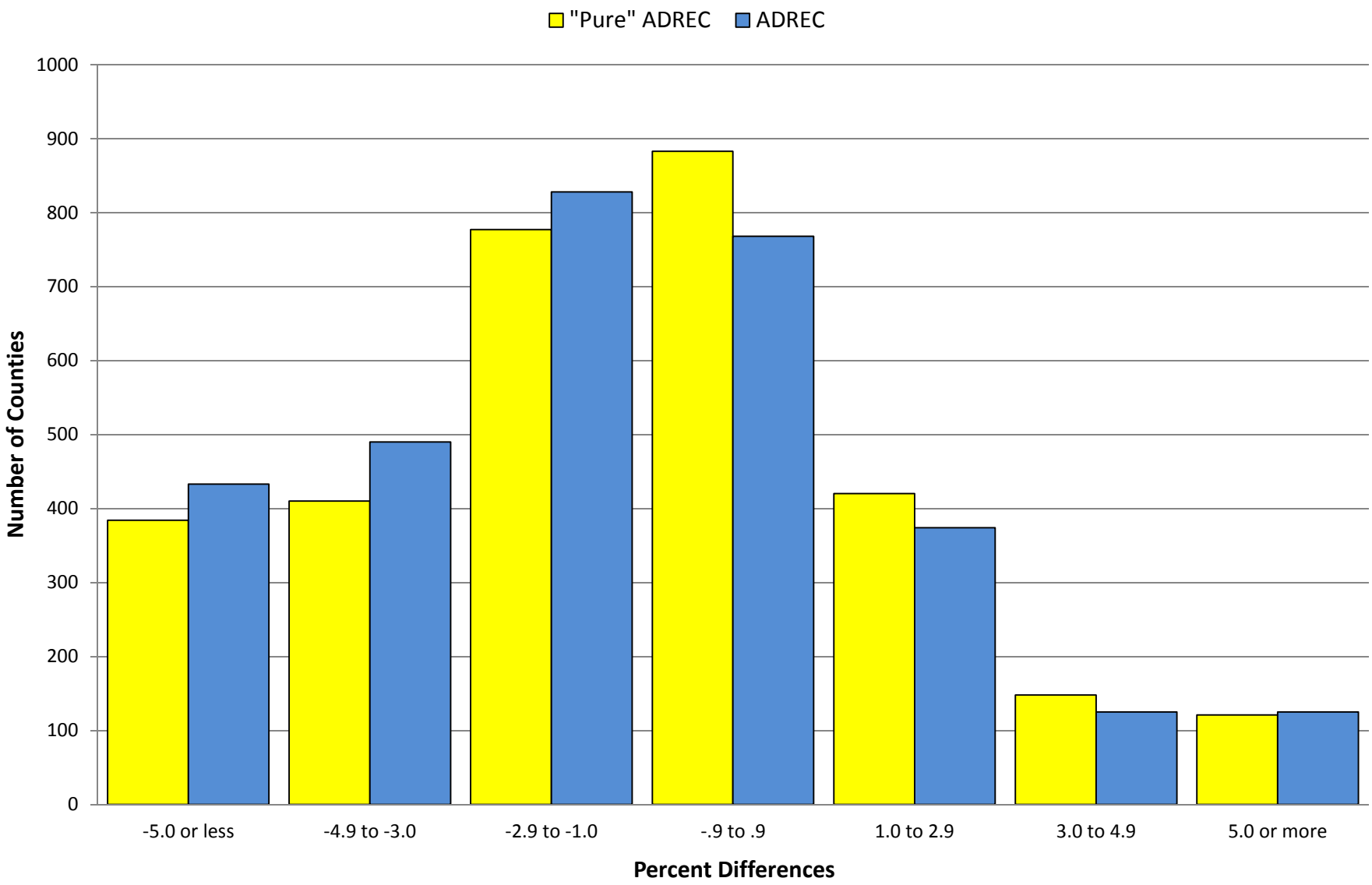
Figure 4. MALPEs for the ADREC Series by County Percent Change: 1990 - 2000 and 2000 - 2010



Notes: The number of counties in each category is at the x axis for each series.
Percent change is calculated as the change from 1990 to 2000 and from 2000 to 2010.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

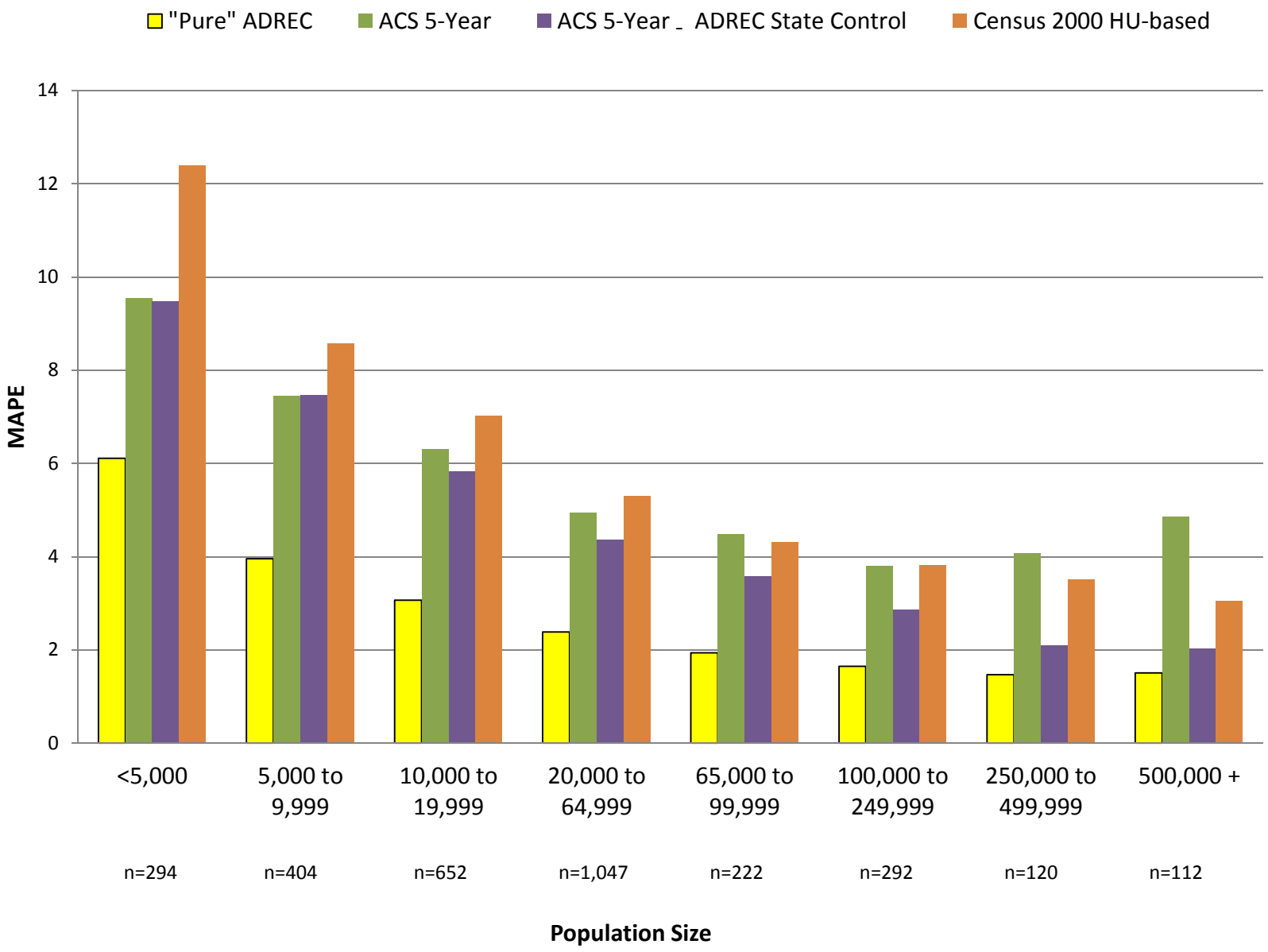
Figure 5. County Distribution of Percent Differences Between Estimate Series and Census Counts: 2010



Note: Negative percent difference indicates that the estimate is lower than the census count.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

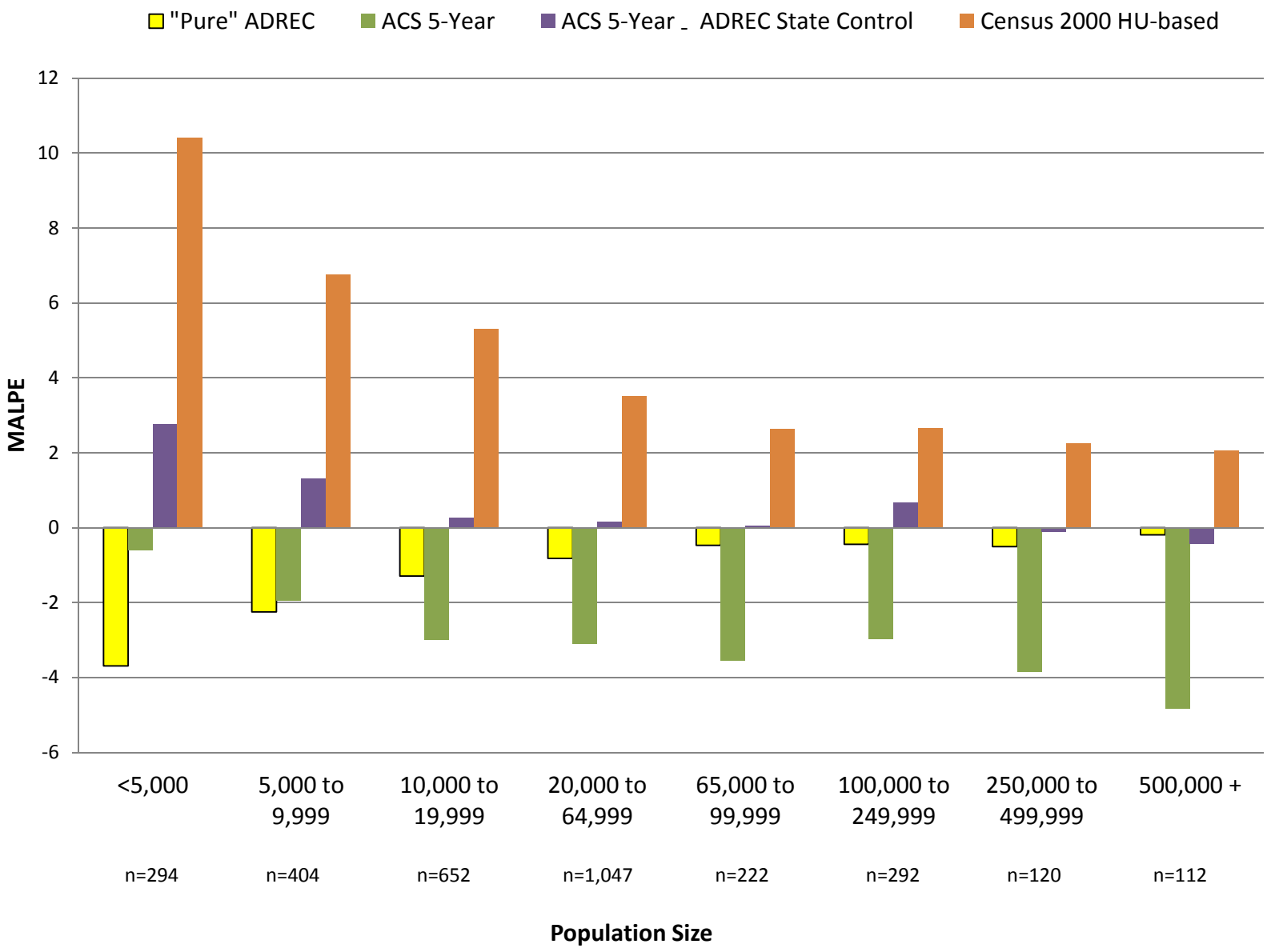
Figure 6. MAPEs for Selected Series by County Population Size: 2010



Note: Population size is based on Census 2000 population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

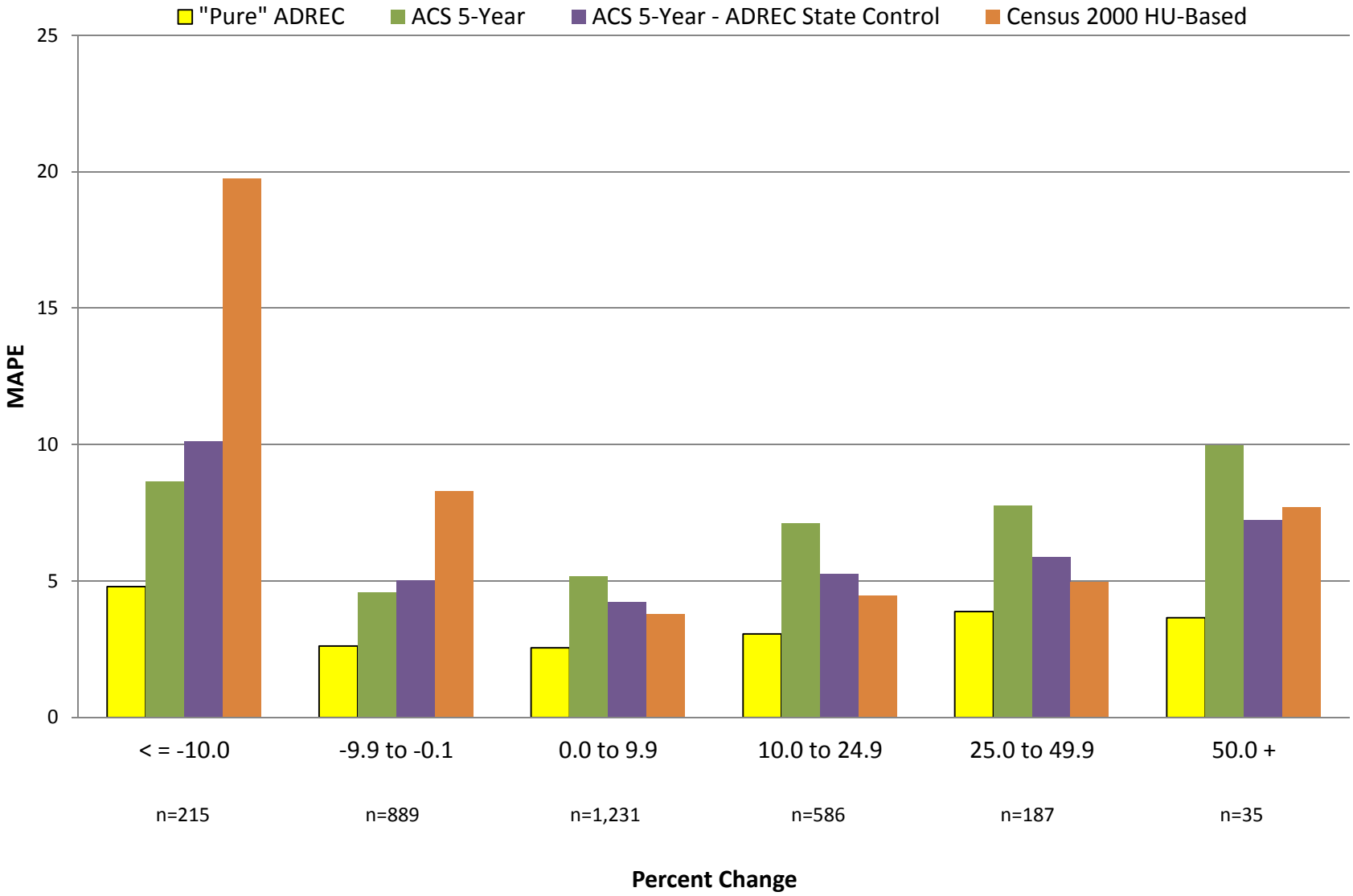
Figure 7. MALPEs for Selected Series by County Population Size: 2010



Note: Population size is based on Census 2000 Population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

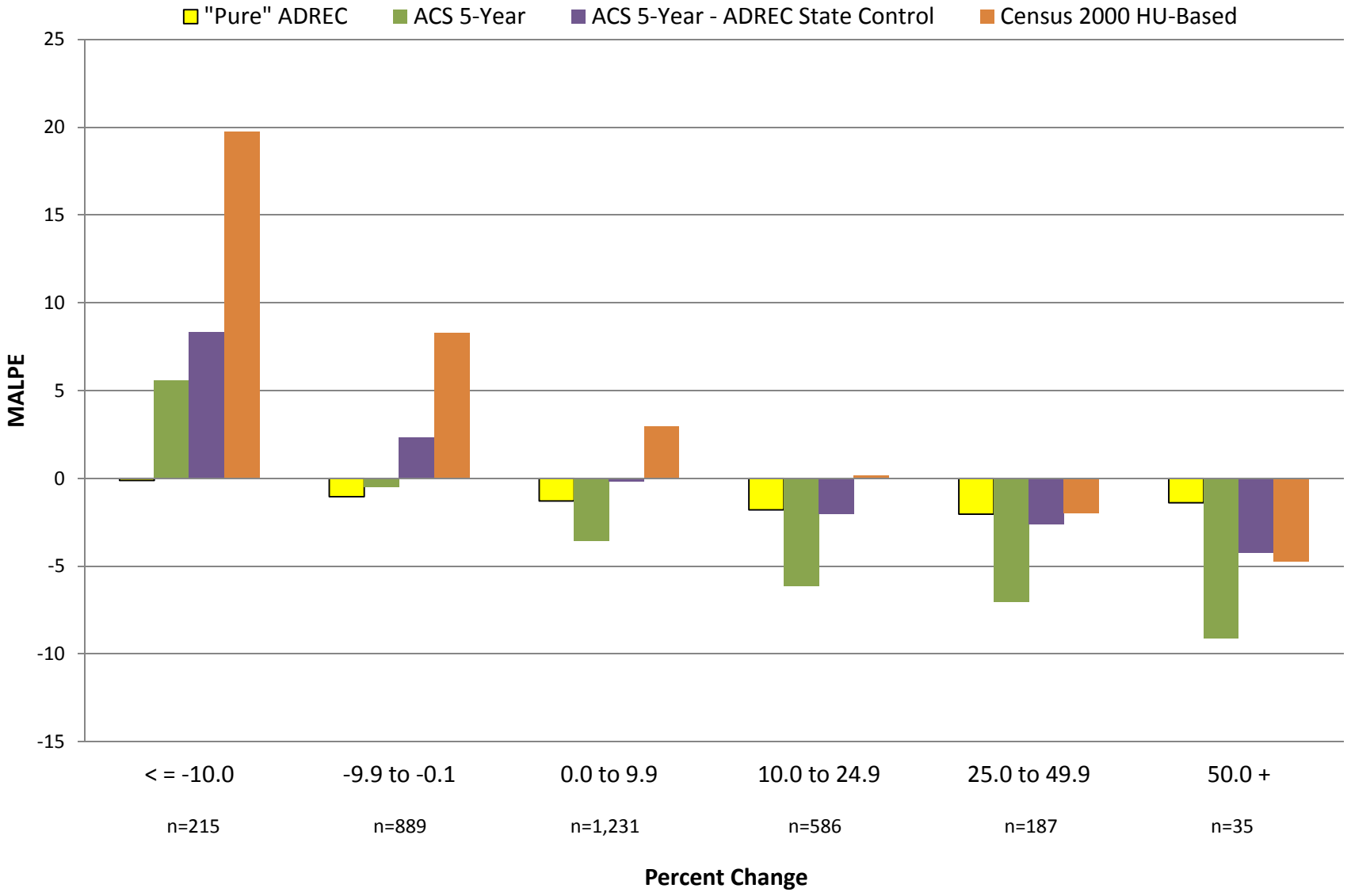
Figure 8. MAPEs for Selected Series by County Percent Change: 2000 - 2010



Note: Percent change is calculated as the change from 2000 to 2010.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

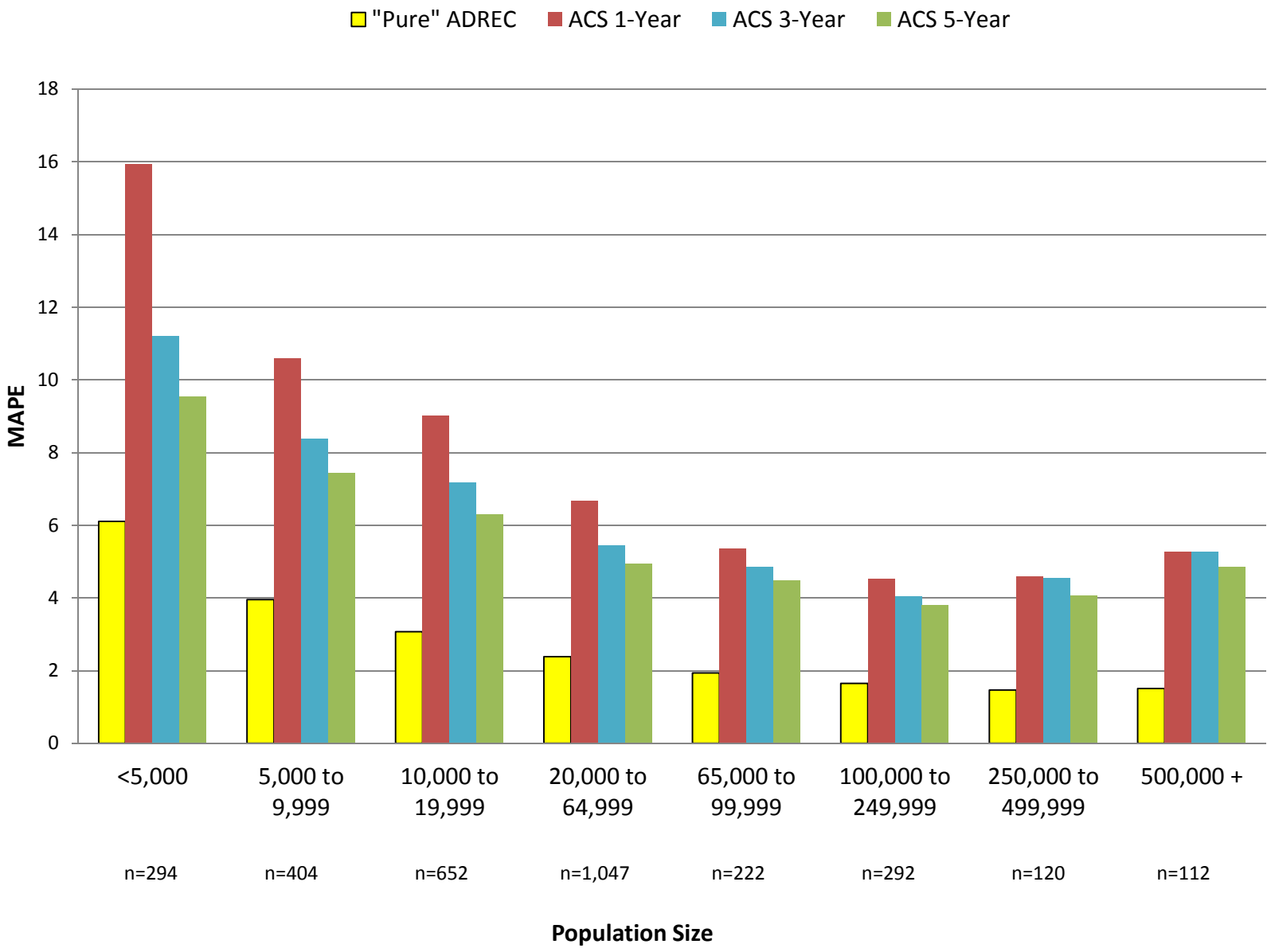
Figure 9. MALPEs for Selected Series by County Percent Change: 2000 - 2010



Note: Percent change is calculated as the change from 2000 to 2010.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

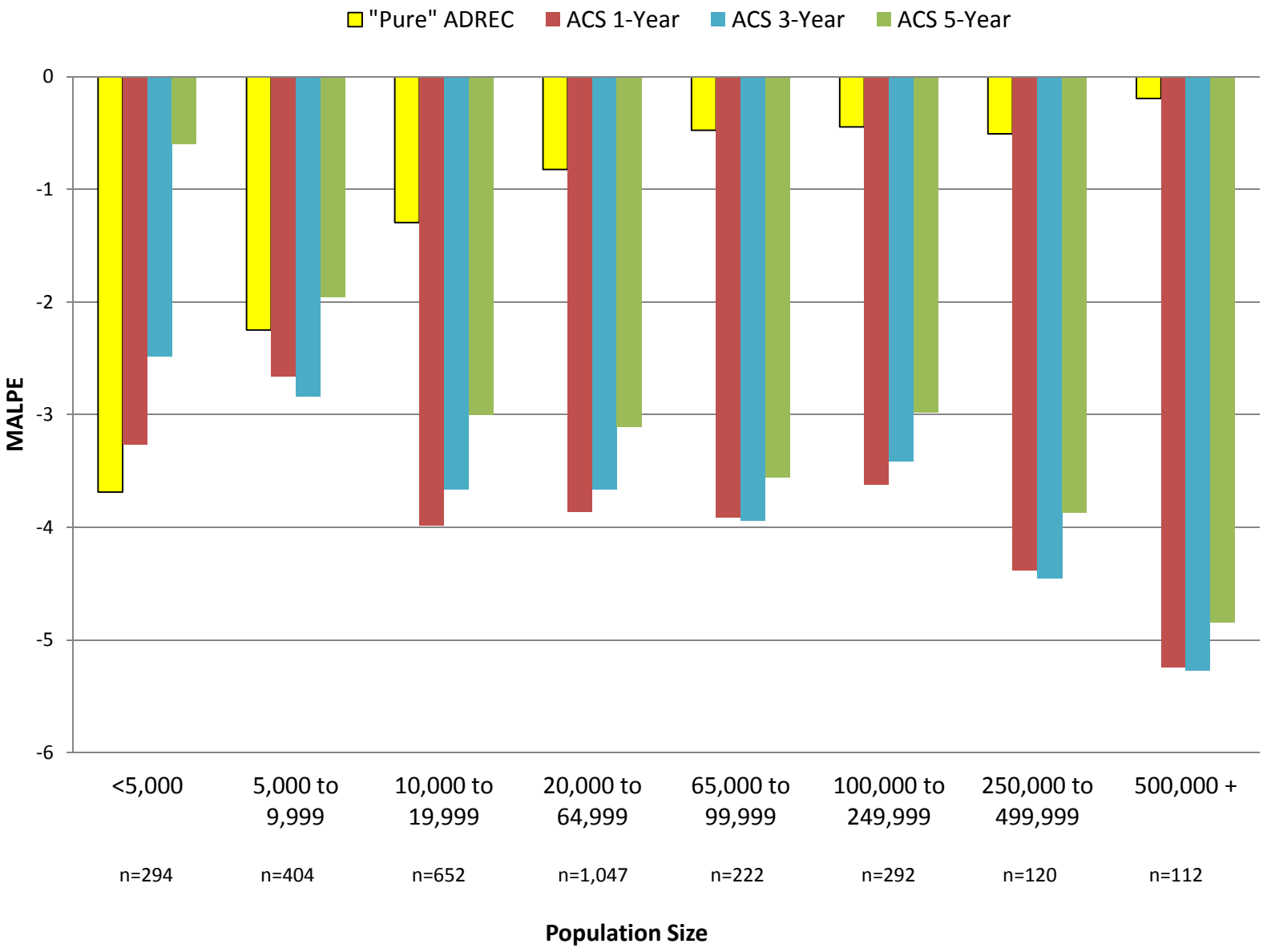
Figure 10. MAPEs for ACS Series by County Population Size: 2010



Notes: "Pure" ADREC series is included for comparison.
Population size is based on Census 2000 population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

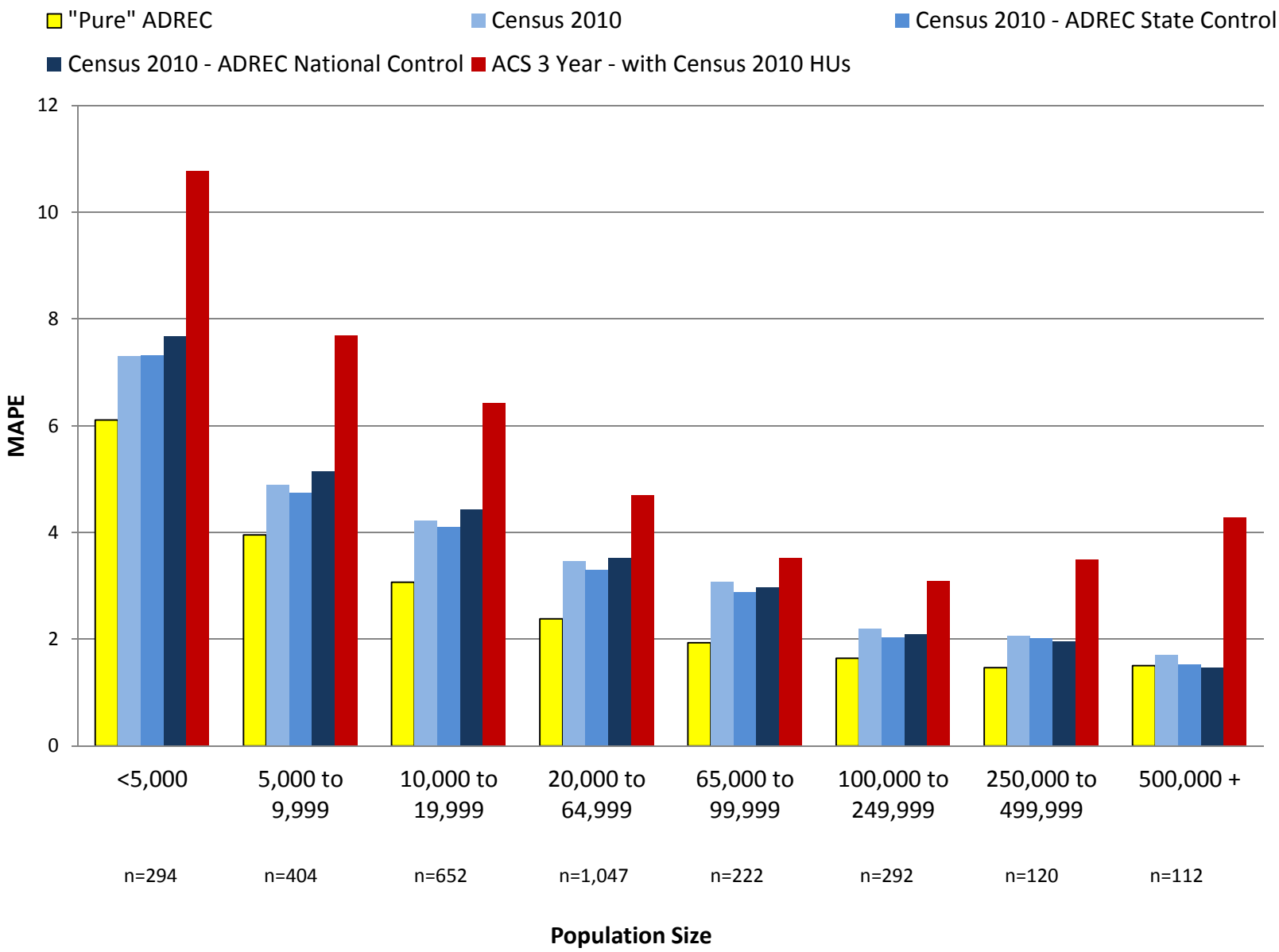
Figure 11. MALPEs for ACS Series by County Population Size: 2010



Notes: "Pure" ADREC series is included for comparison.
Population size is based on Census 2000 population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

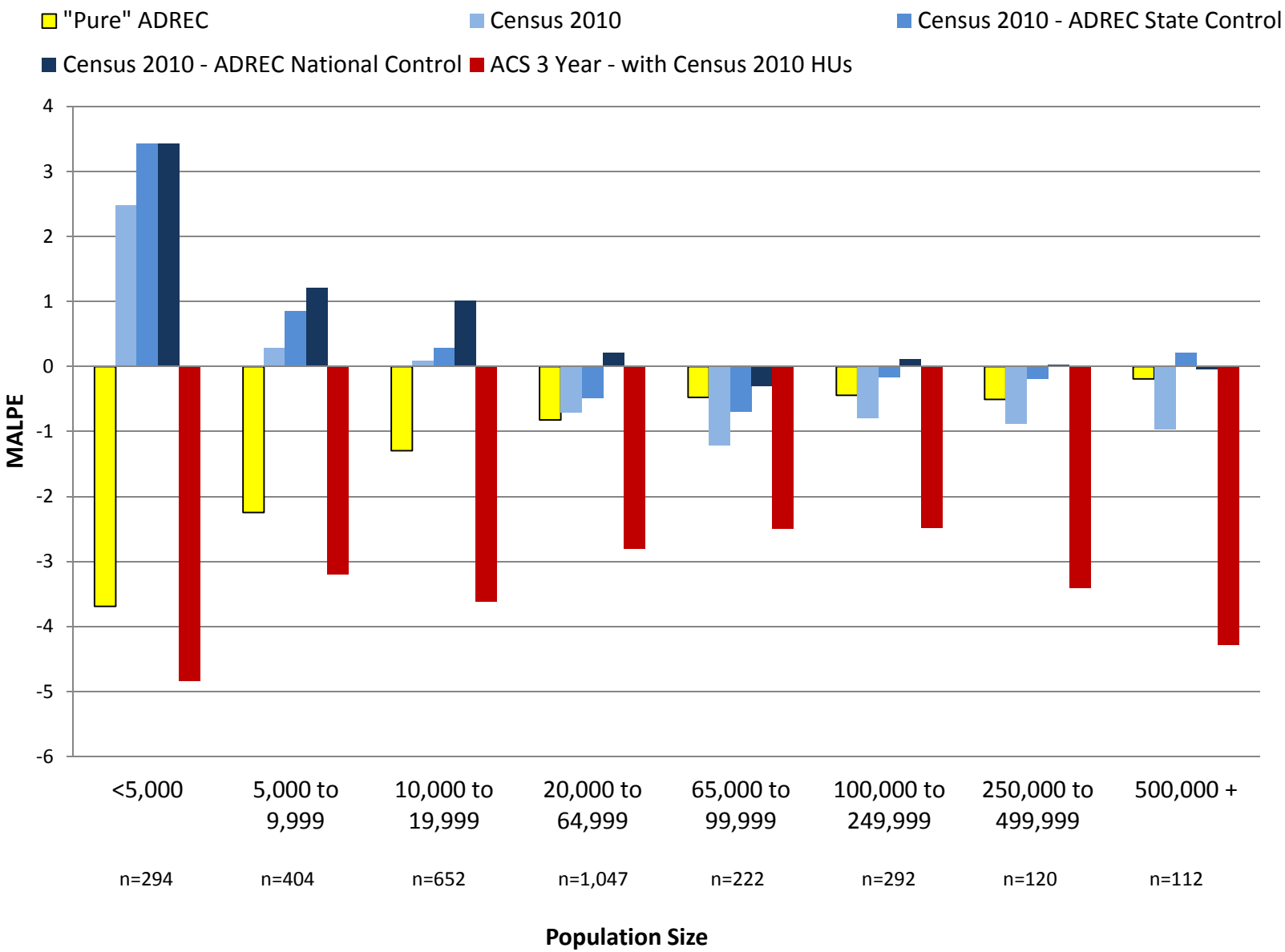
Figure 12. MAPEs for Experimental Series by County Population Size: 2010



Notes: "Pure" ADREC series is included for comparison.
Population size is based on Census 2000 population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.

Figure 13. MALPEs for Experimental Series by County Population Size: 2010



Notes: "Pure" ADREC series is included for comparison.
Population size is based on Census 2000 population.

Source: U.S. Census Bureau, Population Division, Population Estimates Program.