MENDOCINO COUNTY EMPLOYEES RETIREMENT ASSOCIATION

Date: February 21, 2024
To: Board of Retirement
From: F. Robert Reveles, Retirement Financial Investment Officer
Subject: Review of Appropriate Region for MCERA Cost of Living Adjustments

Recommended Action:

Continue to use the Western Region Consumer Price Index for granting Cost of Living Adjustments to retirees.

Fiscal and Financial Impacts:

There are no financial impacts from receiving this report.

Strategic Plan Importance:

This report was brought back at the Board's request in 2018.

Background and Discussion:

Executive Summary

The MCERA Board authorizes an annual Cost of Living Adjustment (COLA) for most retirees based on the Consumer Price Index for All Urban Consumers (CPI-U, or simply CPI) produced by the United States Department of Labor, Bureau of Labor Statistics (BLS). The Government Code directs the Board use the CPI-U for the region in which the County Seat is located.

In 2016 the Board directed staff to conduct an analysis and make a recommendation on the appropriate region to base the COLA. The analysis looked at differences between Bay Area CPI and the Western Region CPI. The results of that study showed the BLS defined Western Region of the United States was a better fit for inflation in Mendocino County.

In 2017 the BLS made several changes to geography definitions, altering the Counties included in the Bay Area region CPI and creating the Pacific Region (referred to hereafter, generally, as Pacific). The MCERA Board again directed staff to review the updated Bay Area Region, Western Region, and Pacific Region to determine the best fit for inflation in Mendocino County. This review also included the California Consumer Price Index (CCPI) region as another potential region since the CCPI is based on BLS data for the Bay Area and Southern California. The results of the 2018 study showed the Western Region was a better fit for inflation in Mendocino County. The Board requested staff review the appropriate COLA region again in 5 years.

This review expands and extends the previous model by including updated Zillow housing data, Housing and Urban Development Fair Market Rent (HUD-FMR) data, BLS CPI data, and US Census Bureau data for each potential CPI region. The regions include the Bay Area, California, Pacific Region, and the Western Region. The analysis finds the Western Region remains the best fit for inflation in Mendocino County.

Introduction

The MCERA Board authorizes an annual Cost of Living Adjustment (COLA) for Non-Public Employees Pension Reform Act (Non-PEPRA) retirees based on a Consumer Price Index for All Urban Consumers (CPI) produced by the United States Department of Labor, Bureau of Labor Statistics (BLS). To calculate the COLA, the Board relies upon Government Code (G.C.) Section 31870.1:

> **§31870.1. Determination; maximum annual change of three percent in allowances; limitation on reduction**
>
> The board shall before April 1 of each year determine whether there has been an increase or decrease in the cost of living as provided in this section. Notwithstanding Section 31481 or any other provision of this chapter (commencing with Section 31450), every retirement allowance, optional death allowance, or annual death allowance payable to or on account of any member, of this system or superseded system who retires or dies or who has retired or died shall, as of April 1st of each year, be increased or decreased by a percentage of the total allowance then being received found by the board to approximate to the nearest one-half of 1 percent, **the percentage of annual increase or decrease in the cost of living as of January 1st of each year as shown by the then current Bureau of Labor Statistics Consumer Price Index for All Urban Consumers for the area in which the county seat is situated**, but such change shall not exceed 3 percent per year; however, the amount of any cost-of-living increase or decrease in any year which is not met by the maximum annual change of 3 percent in allowances shall be accumulated to be met by increases or decreases in allowance in future years; except that no decrease shall reduce the allowance below the amount being received by the member or his beneficiary on the effective date of the allowance or the application of this article, whichever is later.

The provision for a COLA was adopted by MCERA in 1970. From 1971 to 2016, MCERA utilized the CPI-U for the San Francisco-Oakland-San Jose region. In 2016, the Board of Retirement directed staff to conduct an analysis and recommend the appropriate region on which to base the MCERA COLA. The results of that analysis showed the BLS defined Western Region of the United States to be a better fit for Mendocino County in determining the annual COLA. The Board adopted the Western Region CPI-U as the basis for determining the COLA beginning in 2016.

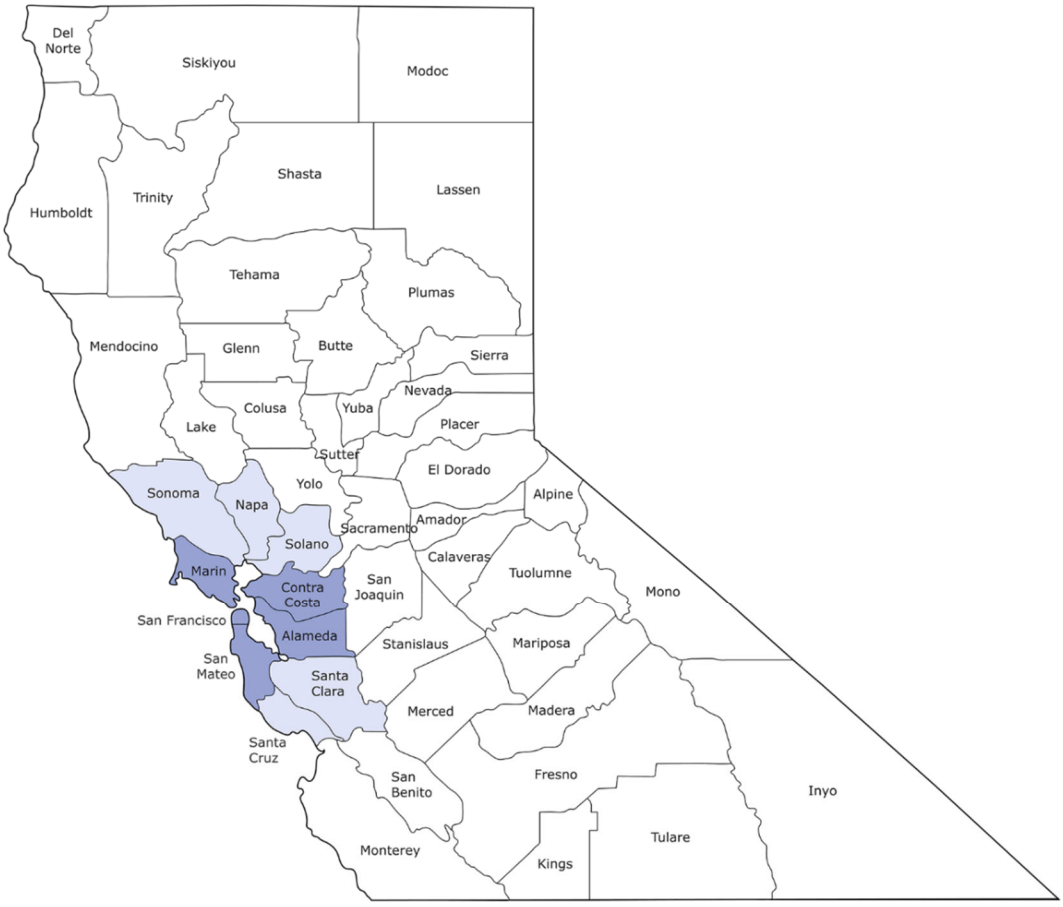
In late 2017, the Bureau of Labor Statistics released information regarding a substantive update to the geography definitions of the BLS. These changes included decreasing the number of Counties

included in the Bay Area geography, changes in the Southern California geography, and the creation of the Pacific Region. The MCERA Board again directed staff to analyze the appropriate region to use for granting retiree COLAs. The 2018 analysis included the California CPI. (CCPI) Though the CCPI is not produced by the BLS, it is calculated based on BLS produced CPI-U figures, allowing the MCERA Board to consider use of the region.

Geographic Areas Defined

Figure 1 below compares the previous Bay Area to the Bay Area after January 1, 2018, as defined by the BLS.

Figure 1. BLS Defined Bay Area Geography, Pre-2018 vs. Post-2018

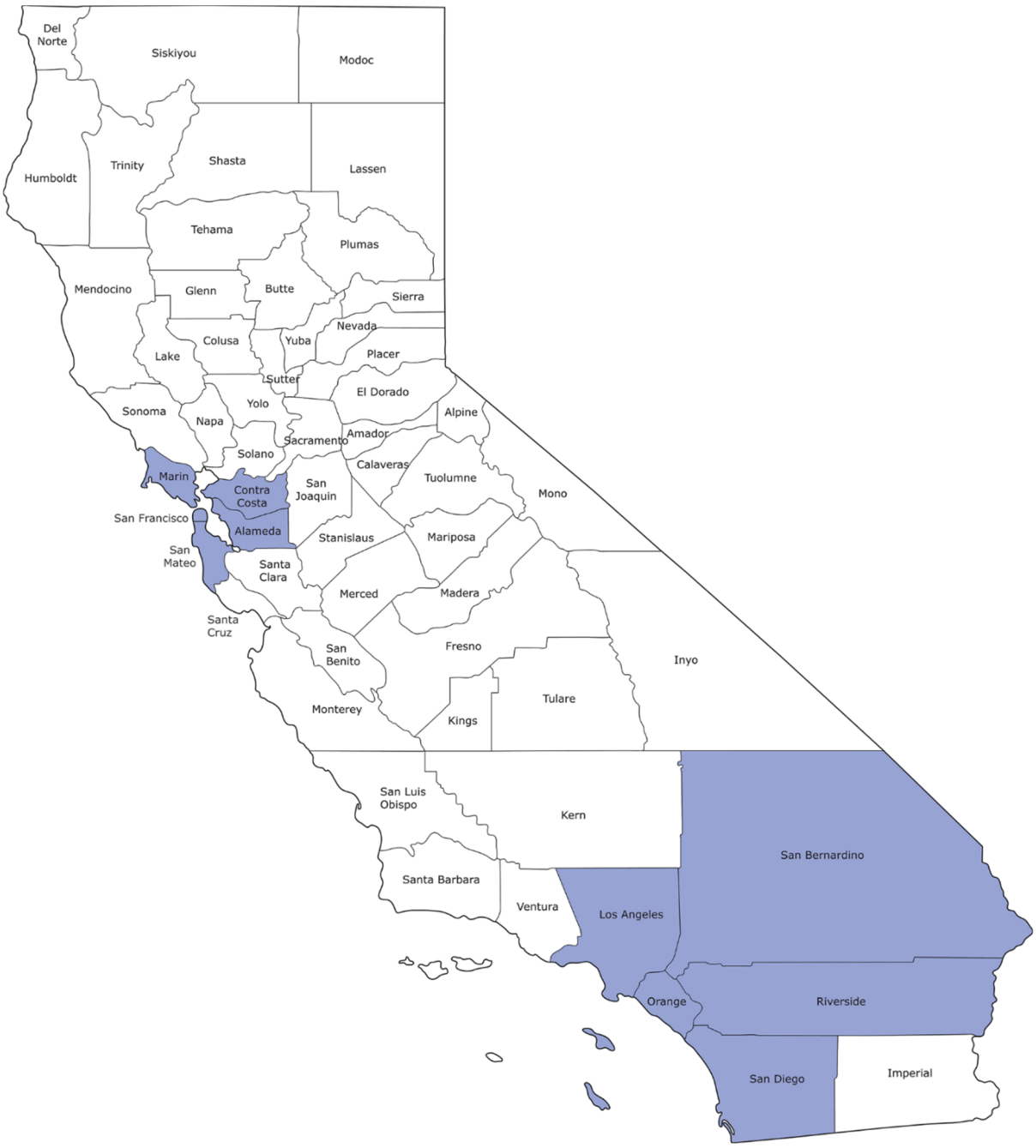


The lighter shaded counties were included in the BLS defined Bay Area geography previously but were removed from the geography effective January 1, 2018. The darker shaded counties in the figure are those that remained in the BLS Bay Area geography after January 1, 2018.

The number of counties in this geography decreased from 10 to 5. The counties removed from the Bay Area as defined by the BLS are: Napa, Santa Clara, Santa Cruz, Solano and Sonoma. The BLS also renamed the Bay Area Geography from San Francisco-Oakland-San Jose to San Francisco-Oakland-Hayward.

Figure 2 shows the regions included in the California CPI (CCPI).

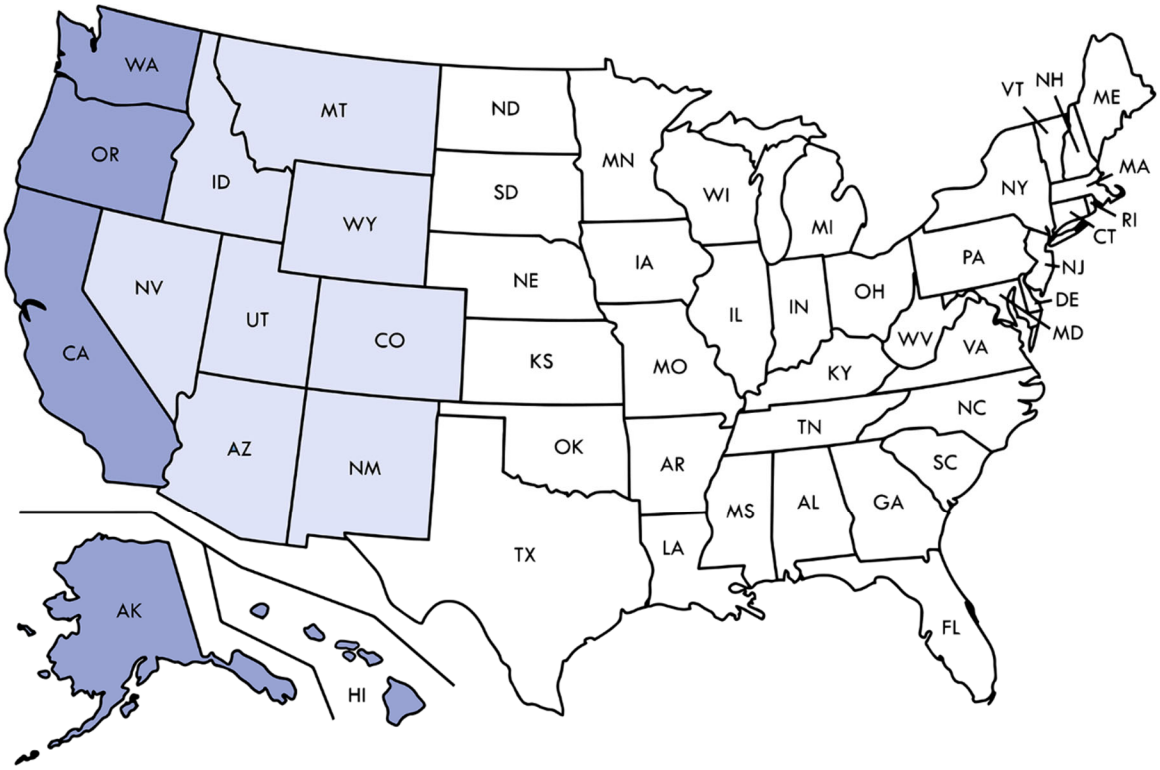
Figure 2. California CPI Region



The CCPI is estimated by the California Department of Industrial Relations (DIR) as an average of the CPI across the geographies provided by BLS. The four geographies included in the CCPI are: Los Angeles-Long Beach-Anaheim, San Francisco-Oakland-Hayward, San Diego-Carlsbad, and Riverside-San Bernardino-Ontario. The CCPI is calculated as a population weighted average across these geographies.

Figure 3 shows the Western region, Pacific Sub-Region, and Mountain Sub-Region.

Figure 3. BLS Western Region: Pacific Sub-Region vs. Mountain Sub-Region, Post-2018



In 2018 the BLS created two sub-regions in the Western Region, the Mountain Sub-Region, and the Pacific Sub-Region. The Pacific Sub-Region includes Alaska, California, Hawaii, Oregon, and Washington. Figure 3 above identifies the states in the Western Region, with the Pacific Sub-Region states shaded darker.

There are four choices of geography when selecting the basis for the MCERA COLA. These options are, in increasing size of population and geography: Bay Area, California, Pacific Sub-Region and Western Region.

Analysis

Consumer Price Index Comparison and Deconstruction

The 2016 analysis began with a review of the Bay Area and Western Region indices and each subcomponent, then deconstructed the index to show the contribution of each subcomponent. Here we follow the same methodology with a few caveats. First, because the CCPI is a population weighted average index of four sub-regions in California we did not attempt to create the same population weighted CPI index construction for each subcomponent for each region. Thus, the graphs on pages 8 and 9 of the CPI subcomponents include only the Bay Area and Western region. Additionally, because the Pacific Region was created in 2017 (as an index base of 100 for each subcomponent) there is little value showing the individual subcomponents of the Pacific Region. Finally, the total CPI (All Items) for each region was rebased to 100 as of 2017 so Trustees can see the differences since that time. (Figure 5 on page 7)

Figure 4 below shows the CPI for the Bay Area, the Western, and the California Regions. The series are indexed such that the average values between 1982 and 1984 are equal to 100. The figure shows the CPI for the Bay Area is higher than the CPI for the Western and California Region. Note how the CPIs since 2019 have converged.

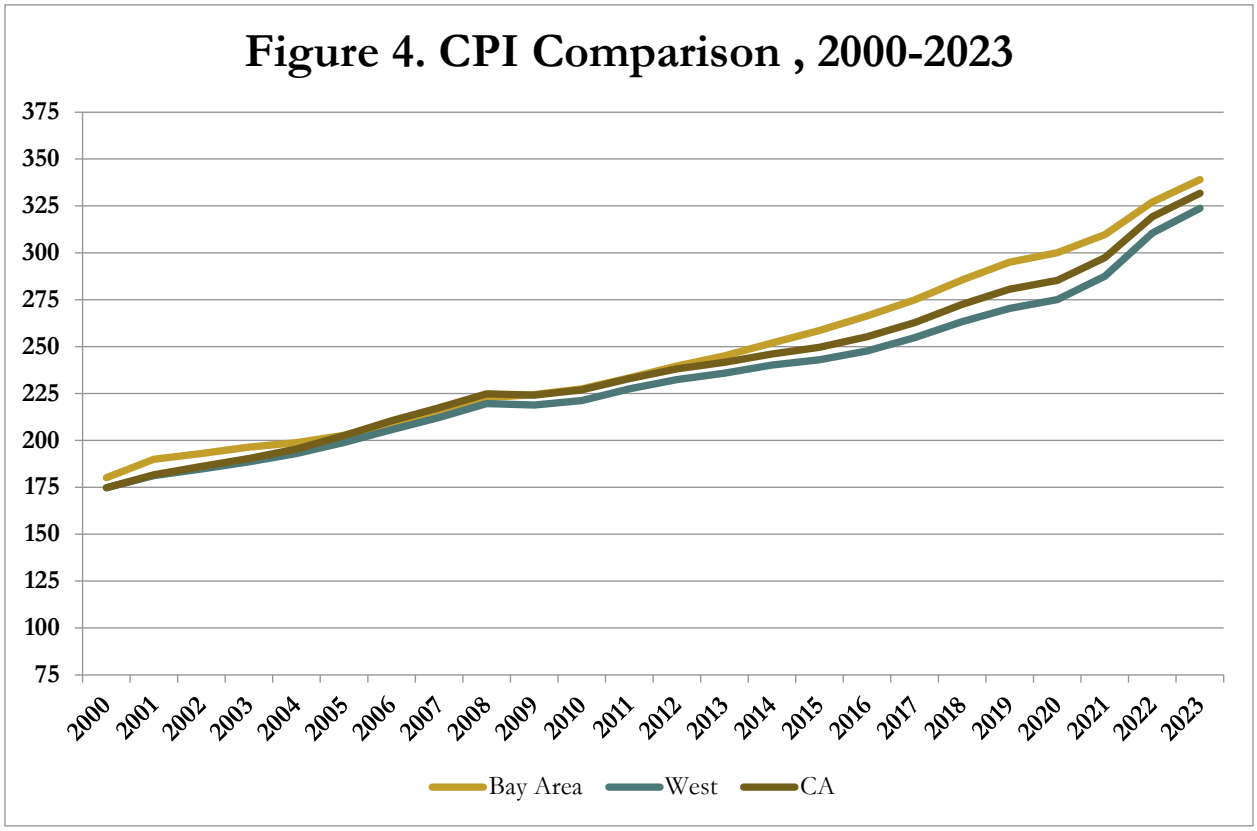
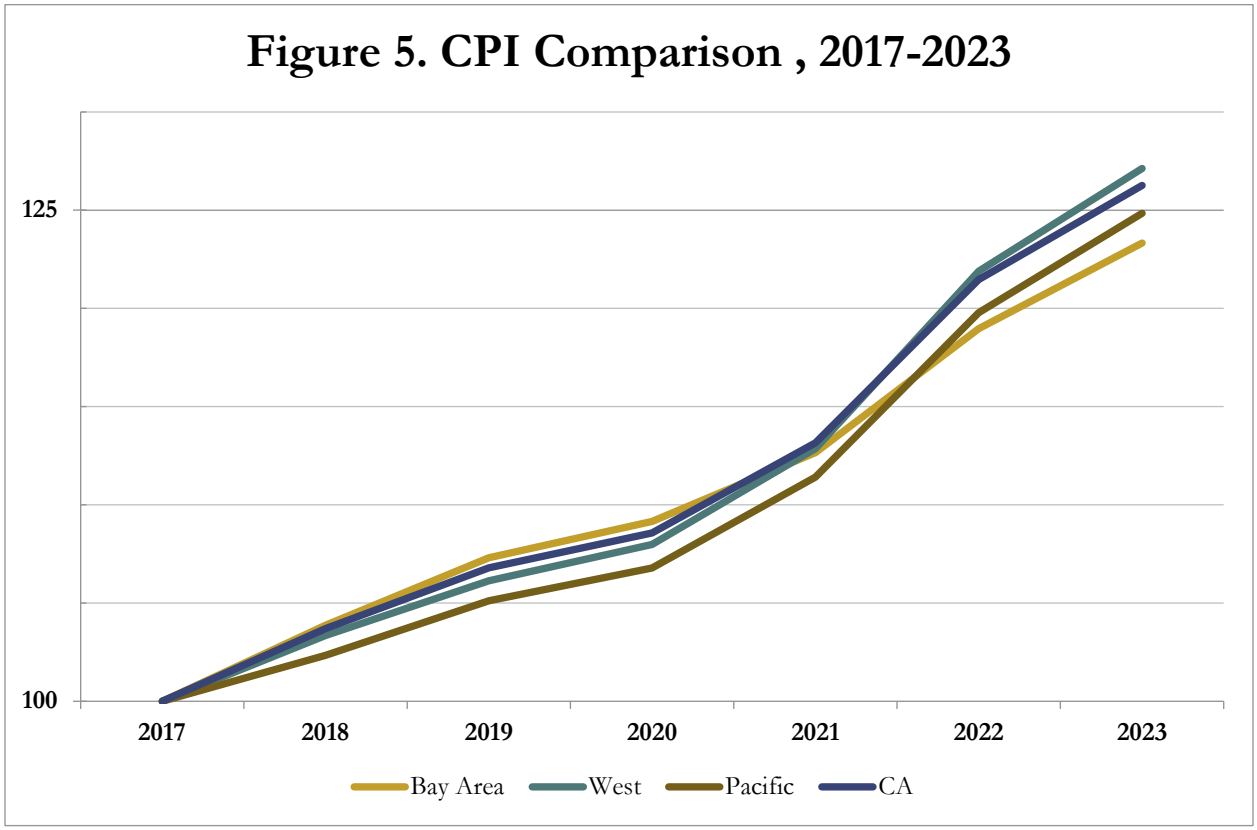


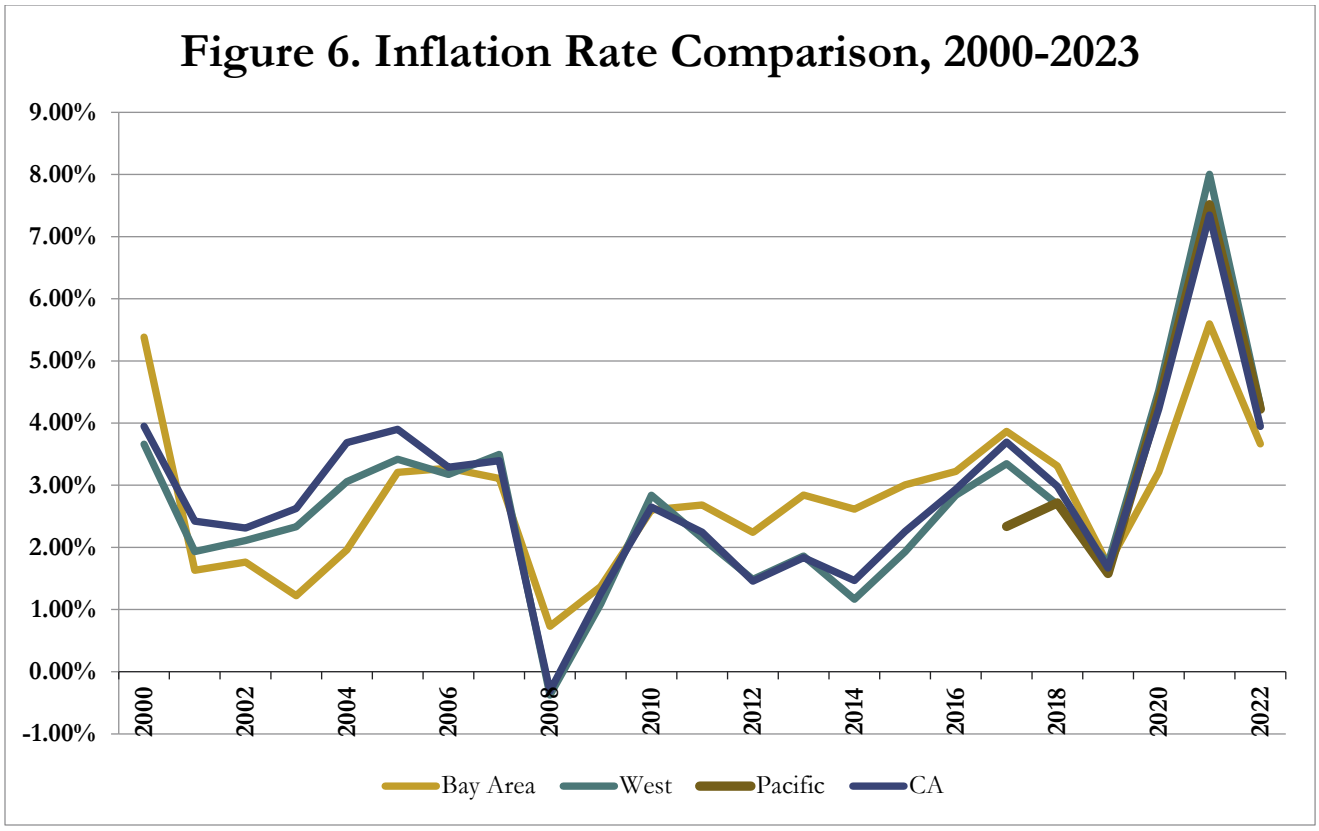
Figure 5 below shows the CPI for the Bay Area, the Pacific Region, the Western, and the California Regions since 2017. Here we can see between 2019 and 2023 the Bay Area region went from having the highest CPI to having the lowest CPI. This rate of change is reflected in Figure 4 above by the convergence of the lines by the end of 2023. The Western Region experienced the greatest rate of inflation since 2017.



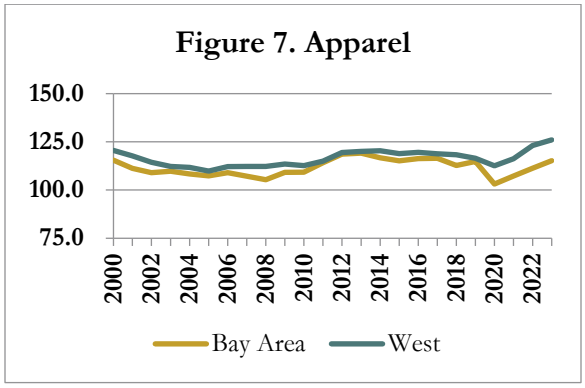
The inflation rate is calculated as:

$$Inflation\ Rate_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} = \frac{CPI_t}{CPI_{t-1}} - 1$$

where t is the year. Figure 6 on the next page shows the calculated inflation rate for the four areas based on the CPI in December of each year.



The CPI is also calculated for several major categories including "Apparel", "Education and Communication", "Food and Beverage", "Housing", "Medical Care", "Other Goods and Services", "Recreation" and "Transportation". The CPI for the Bay Area and Western Region (2000 – 2023) for each category are shown in the following graphs.



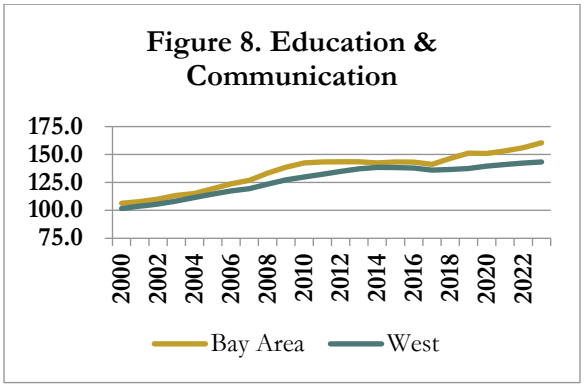


Figure 9. Food & Beverage

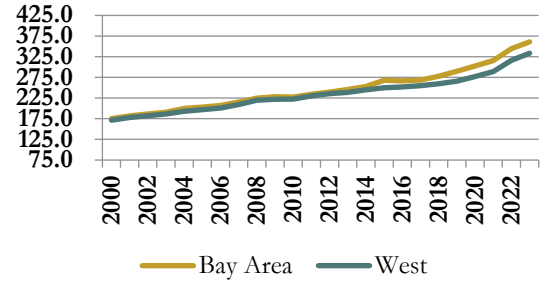


Figure 10. Housing

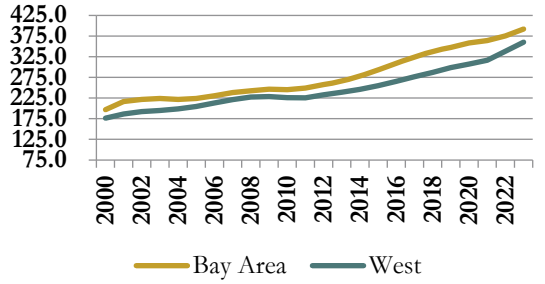


Figure 11. Medical Care

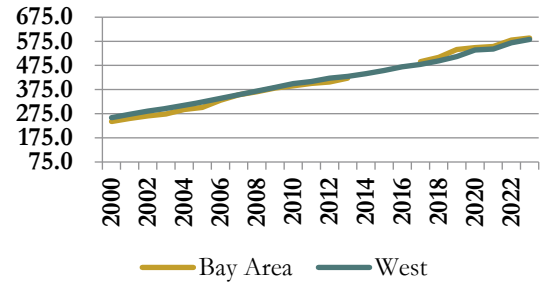


Figure 12. Other Goods & Services

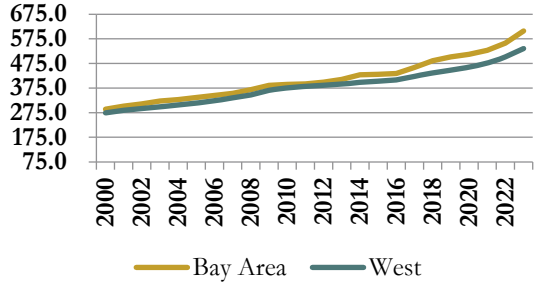


Figure 13. Recreation

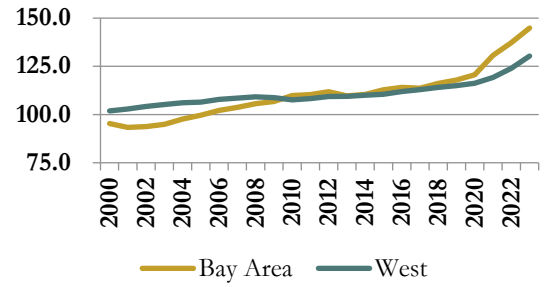
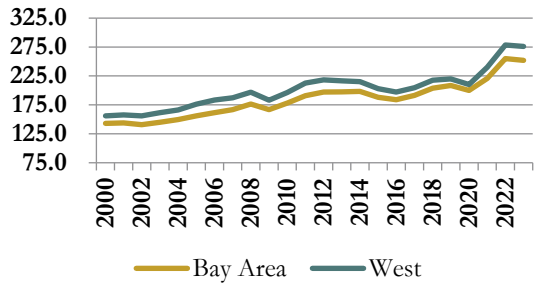


Figure 14. Transportation



Like the 2016 analysis, we check the differences between the CPI for the Bay Area and Western Region using the similarity index,

$$Similarity\ Index = \sum_{i=1}^{n} (x_i - y_i)^2$$

where x_i is the i^{th} observation in series X and n is the total number of observations in the series. The closer the Similarity Index is to zero, the more similar are the two series.

Table 1 shows the similarity index when comparing the CPI for Bay Area to the CPI for the Western Region in total and for the major components of the CPI index.

Table 1. Bay Area – Western Region CPI Similarity Index, 1982 – 2023

Category	Similarity Index
Total	4,463.21
Apparel	1,750.82
Education and Communication	1,991.28
Food and Beverage	5,120.70
Housing	26,890.77
Shelter (Housing Subcomponent)	32,588.10
Medical Care	5,369.34
Other Goods and Services	28,473.68
Recreation	1,134.80
Transportation	8,792.92

The similarity index values show two categories in which the regions differ the most, Housing and Other Goods and Services. (Shelter is a subcomponent of Housing) The Housing category is comprised of expenses involved with the provision of housing including the cost of owner-occupied housing, rent and utilities. Other Goods and Services includes tobacco and smoking products, personal hygiene products, and personal services like legal, laundry, financial, or funerary services. Shelter is a subcomponent of Housing and includes only the expense in obtaining a shelter or dwelling. Shelter excludes the cost of utilities. The similarity index only tells us that these two categories are the most different, not which category contributes more toward the differences in CPI.

Again, we follow the methodology from the 2016 analysis to answer the question of which category contributes more to the differences in regional CPI. We can now easily include the Pacific Region, though there is significantly less data. We construct a new CPI for the three regions using the category CPI and the BLS produced Importance Factor.

The Importance Factor is a measure of the significance of each category in the total CPI. For example, in 2022 the importance factor for Housing was 44.38, whereas the corresponding factor for Apparel was 2.48. The Importance Factors are based off U. S. city averages and are currently available through calendar year 2022.

Multiplying the CPI of each category by its scaled Importance Factor allows us to construct a new CPI for each region

$$Constructed\ CPI_t = \sum_{c=1}^{n} CPI_{c,t} * \frac{Importance\ Factor_{c,t}}{100}$$

where c is the Category. It should be noted that the values of the Constructed CPI are different than the BLS provided CPI in levels. This issue is not a concern since we are attributing the differences in the two CPI measures instead of comparing a series over time.

Additionally, while the values of the Constructed CPI are different than the CPI provided by BLS, the series are highly correlated. The correlation coefficient between the reported CPI and constructed CPI is 0.997 for the Bay Area, 0.999 for the Western Region and 1.000 for the Pacific Region.

Since the Constructed CPI for an area is a sum of its Importance Factor weighted Category CPIs, we can now examine the differences between the three regions and attribute the difference in total to the categories. This is accomplished via the formula (with Bay and Western regions as example)

$$Share\ of\ CPI\ Difference\ _{c,t} = \frac{Bay\ Area\ CPI_{c,t} - West\ CPI_{c,t}}{Bay\ Area\ Total\ CPI_t - West\ Total\ CPI_t}$$

where c is the Category. As a test, if the sum

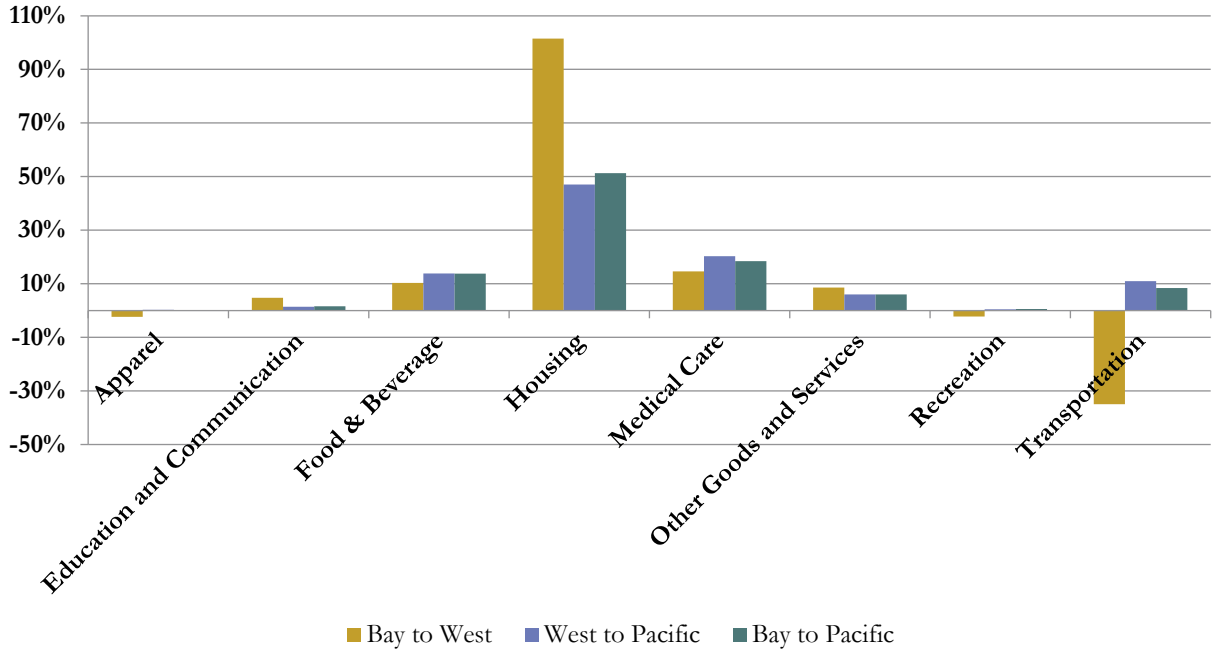
$$\sum_{c=1}^{8} Share\ of\ CPI\ Difference_{c,t}$$

equals 1 (or 100%), then we have decomposed the difference in the Constructed CPI accurately. This is indeed the case.

We then average *Share of CPI Difference* by category over the time period 1998 – 2022 as this is the period over which we have comparable data. (For Pacific Region we use 2017 – 2022) Taking the average over time provides a more accurate indication of how important each category is in explaining the differences, as extreme values in either direction are mitigated.

This average figure then indicates the percent of the total difference between the Bay Area CPI, the Western Region CPI, and the Pacific Region CPI that is caused by the differences in the corresponding CPI for each category. These averages are shown in Figure 15 below.

Figure 15. Average Share of Difference in Constructed Index



In Figure 15 we can see, the categories Apparel, Recreation and Transportation negatively contribute to the difference between the Bay Area CPI and the Western Region CPI. These three categories lessen the difference between the Bay Area CPI and the Western Region CPI. Alternatively, the categories Education and Communication, Food and Beverage, Housing, Medical Care, and Other Goods and Services all increase the difference between the Bay Area CPI and the Western Region CPI. When comparing the West to the Pacific and the Bay to the Pacific no categories negatively contribute to the CPI difference. (It could be interesting to delve into the differences of the three negatively contributing categories between the Bay and Western Region, that is a project for another day!)

Figure 15 shows that the differences between the Bay Area, Pacific, and Western Region CPI are still driven primarily by differences in the cost of housing. (Though Medical Care and Food & Beverage contributing as well) This analysis shows that it is still reasonable to use the cost of shelter as a proxy for the differences between regional CPI. The next step in the analysis is to examine the cost of housing in Mendocino County, the Bay Area, the Pacific Region, and the Western Region.

Cost of Housing

We use two different data series to measure the cost of housing in the five Geographies. (Mendocino County, Bay Area, California, Pacific Region, and Western Region) First we examine home values using data available from Zillow. Home values are not a direct component of the CPI, as a home purchase is viewed as an investment when measuring economic activity. However, home values still serve as a valid proxy for measuring the difference in the cost of housing in the regions.

To address the criticism that home values are not a component of the CPI, we next consider data from the United States Department of Housing and Urban Development (HUD). HUD administers the Housing Choice Voucher program, frequently called Section 8 Housing. As part of the program, HUD estimates Fair Market Rents (FMR) by county which we also analyze below.

Zillow Home Value Index

To compare the cost of housing in Mendocino County to the Bay Area, California, the Pacific Region, and the Western Region, we use time series data from Zillow. The Zillow Home Value Index (ZHVI) has changed the construction methodology since the last CPI review, more information is available at the website https://www.zillow.com/research/methodology-neural-zhvi-32128/. (Home value estimates are more accurate.)

As explained by Zillow:

> "**Zillow Home Value Index (ZHVI):** A measure of the typical home value and market changes across a given region and housing type. It reflects the typical value for homes in the 35th to 65th percentile range. Available as a smoothed, seasonally adjusted measure and as a raw measure.
>
> Zillow publishes top-tier ZHVI ($, typical value for homes within the 65th to 95th percentile range for a given region) and bottom-tier ZHVI ($, typical value for homes within the 5th to 35th percentile range for a given region).
>
> Zillow also publishes ZHVI for all single-family residences ($, typical value for all single-family homes in a given region), for condo/coops ($), for all homes with 1, 2, 3, 4 and 5+ bedrooms ($), and the ZHVI per square foot ($, typical value of all homes per square foot calculated by taking the estimated home value for each home in a given region and dividing it by the home's square footage)."

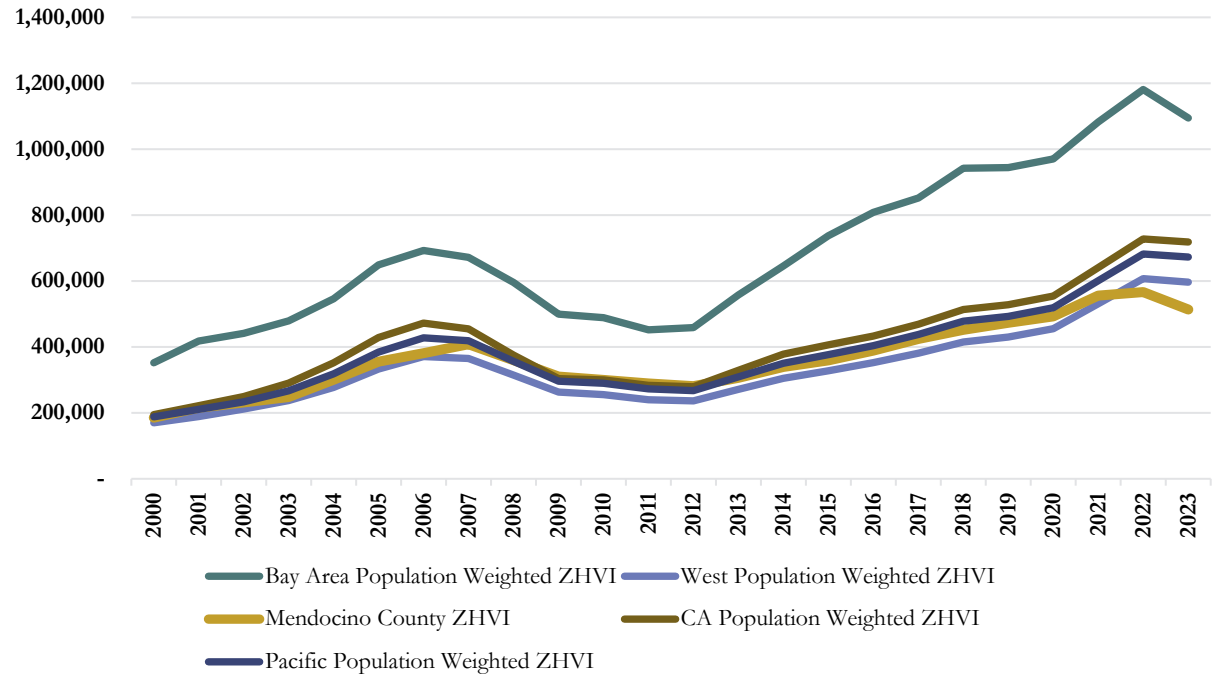
The ZHVI for Mendocino County starts in 2003. Accordingly, we use the previous analysis's ZHVI values for the years 2000, 2001, and 2002 in Mendocino County. For all other data we use the All Homes, Smoothed, Seasonally Adjusted data and we average each area over the twelve months of each calendar year from 2000 to 2023.

We create a population weighted ZHVI for the Bay Area, California, the Pacific Region, and the Western region using

$$Population\ Weighted\ Regional\ \ ZHVI_t = \frac{\sum_{i=1}^{n} ZHVI_{i,t} * Population_{i,t}}{\sum_{i=1}^{n} Population_{i,t}}$$

where i is the i^{th} area and n is the number of areas in the region. We use population data from the United States Census Bureau for July 1 of each year. Figure 16 on the next page shows the Mendocino ZHVI and the Population Weighted ZHVI for the Bay Area, California, Pacific Region and Western Region from 2000 – 2023.

Figure 16. Zillow Housing Value Index



The exact ZHVI levels are not important. What does matter for our analysis is the slope of the curve of each ZHVI over time. Mendocino County is closer to the Western Region above in terms of levels, but we need further analysis to determine whether the slope of the Mendocino County curve is closer to that of the Bay Area, California, Pacific Region, or the Western Region. Going forward we will drop the "Population Weighted" label from the regions for convenience.

There are several methods for assessing the "goodness of fit" between the Mendocino County ZHVI and the other regions. The first and simplest such method is to simply plot the series on a scatter plot for a visual examination. Figures 17 to 20 on the next two pages plot the Mendocino County ZHVI against each region. Using just a visual examination it is difficult to tell which region fits best.

Figure 17. Comparison of Zillow Home Value Index

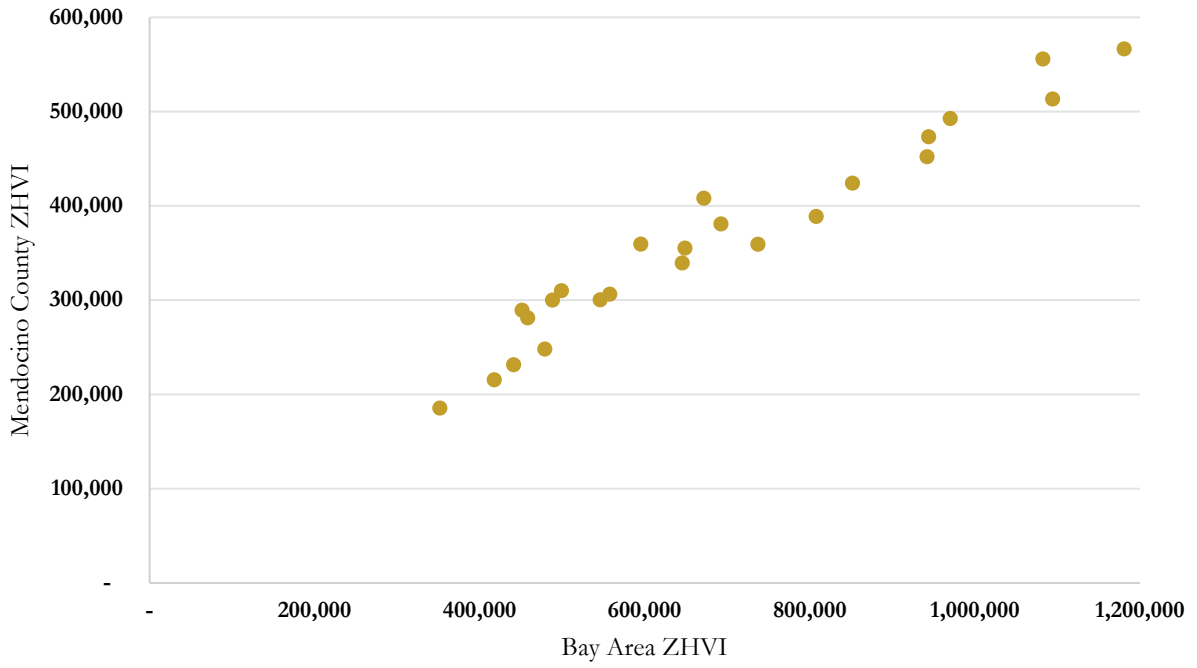


Figure 18. Comparison of Zillow Home Value Index

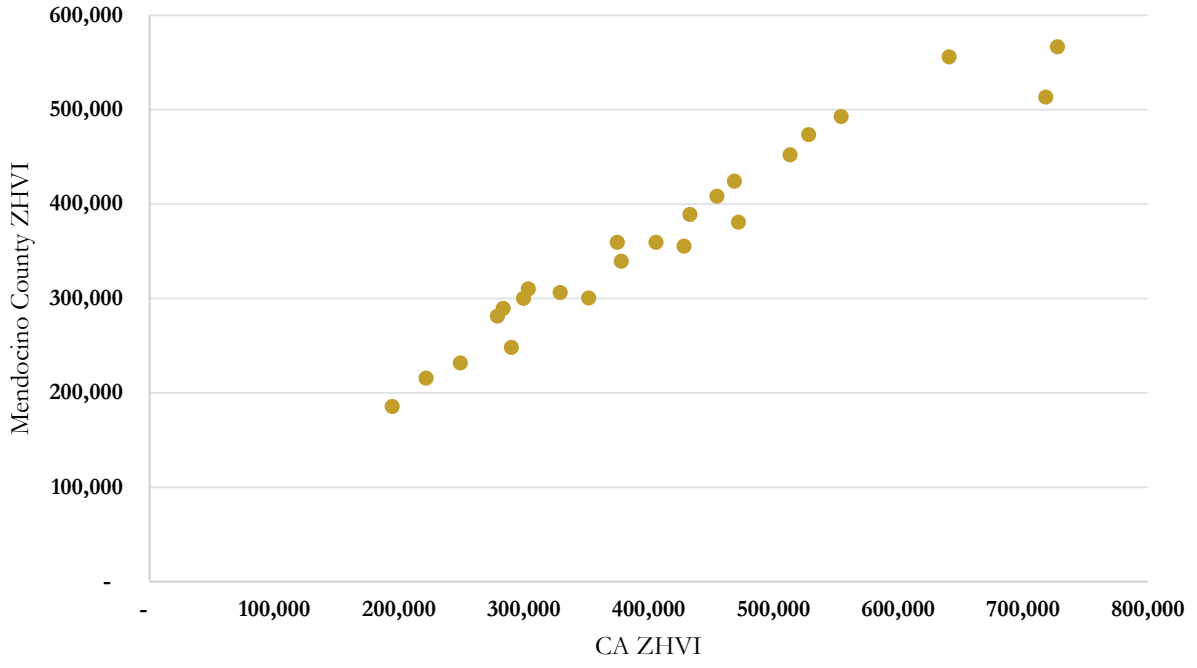


Figure 19. Comparison of Zillow Home Value Index

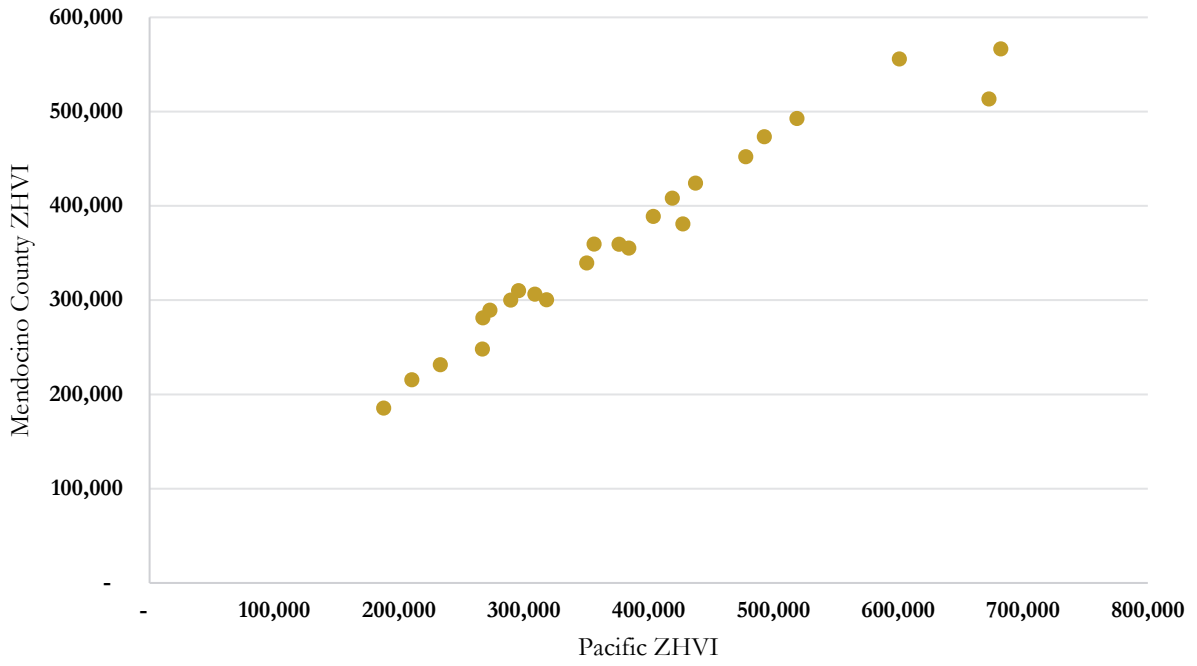
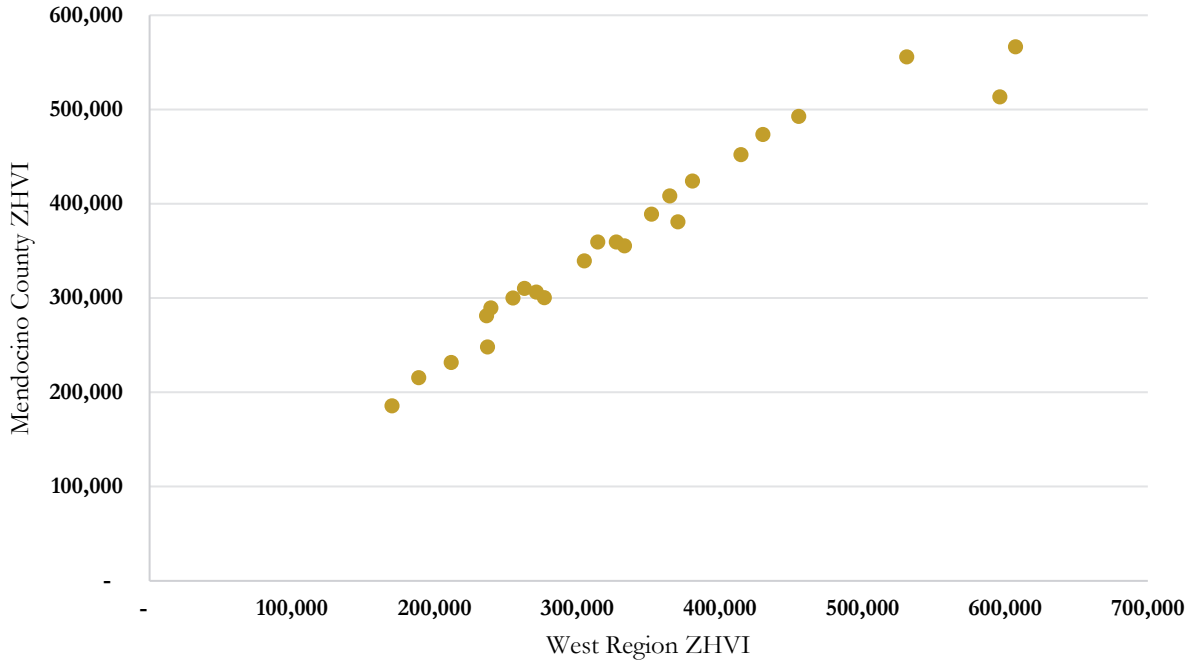


Figure 20. Comparison of Zillow Home Value Index



To test the goodness of fit we can calculate the correlation coefficient, r. The formula for r is

$$r = \frac{\sum_{i=i}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2}\sqrt{\sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

where $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$, the average of x_i. The result for r is between -1 and 1 inclusive with more extreme values indicating a stronger correlation. A negative (positive) value for r indicates an inverse (direct) correlation. Table 2 below shows the correlation coefficient for Mendocino ZHVI – Bay Area ZHVI, Mendocino ZHVI – CA ZHVI, Mendocino ZHVI – Pacific Region ZHVI, and Mendocino ZHVI – Western Region ZHVI from 2000 to 2023.

Table 2. Correlation Coefficient of ZHVI for Geographies

Geographies	Correlation Coefficient
Mendocino – Bay Area	0.973885
Mendocino – CA	0.973356
Mendocino – Pacific Region	0.976202
Mendocino – Western Region	0.972290

The calculated values for the correlation coefficient confirm that indeed all regions are closely correlated over the period. The Pacific Region shows the closest correlation to Mendocino County over the given period.

Additional insight is found by examining the correlation coefficients over time. Figure 21 below shows the correlation coefficient for the regional comparisons from 2000 to the year indicated in the figure. That is, the value in the figure for 2020 shows the correlation coefficient from 2000 to 2020 between the ZHVI for the different geographies.

Figure 21. ZHVI Correlations, 2000 to End Year

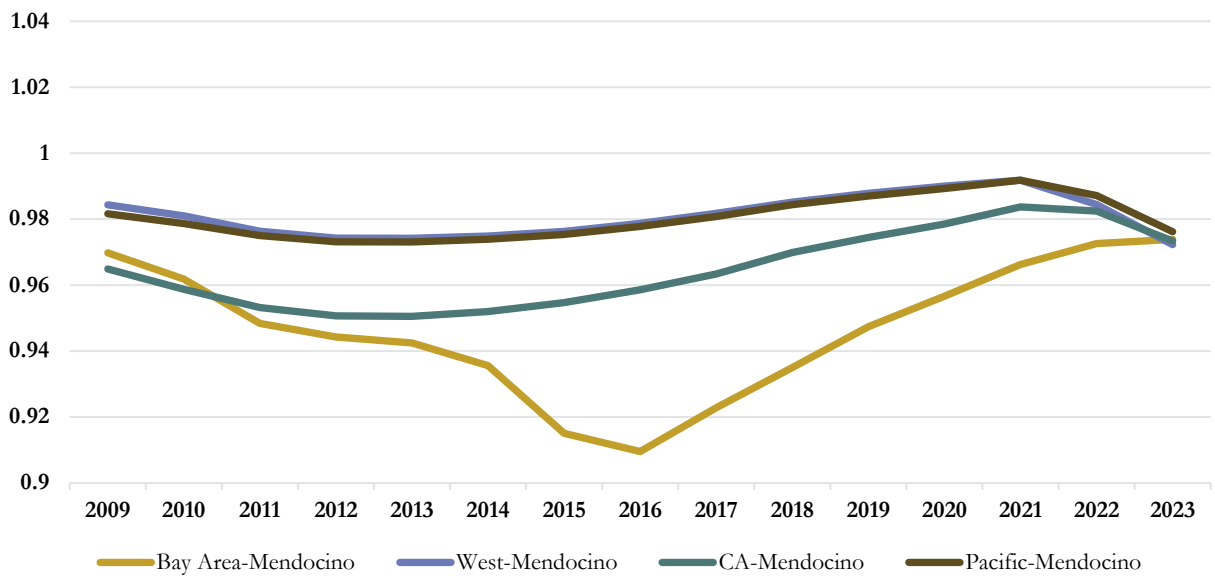


Figure 21 shows that over the last 23 years Pacific and West correlation coefficients have changed relatively little, while the Bay Area and California regions have varied by a larger amount.

This result is also reflected in Figure 16 above where one can see the gap increase between the Bay Area ZHVI and all other ZHVI series after 2012. Here we can see that Mendocino County ZHVI has a stronger direct correlation to the Pacific and Western Regions than the Bay Area or California.

The next method by which we can compare ZHVI in Mendocino County to the other regions is by calculating the average annual growth rate of each series. We use two different methods to calculate the average annual growth rate. The first is using the geometric mean

$$GM(ZHVI) = \left(\frac{ZHVI_t}{ZHVI_1}\right)^{\frac{1}{t-1}} = \sqrt[t-1]{\frac{ZHVI_t}{ZHVI_1}}$$

where t is the number of time periods. It is worth noting that using the geometric mean to calculate the average annual growth rate is required by the Global Investment Performance Standards (GIPS) of the Chartered Financial Analyst (CFA) Institute if a financial firm indicates their reports are GIPS-compliant.

The weakness of the geometric mean approach in calculating average annual growth is that it ignores the growth path. One can see in the equation on the previous page the only values of the series involved in calculating the geometric mean are the initial and terminal values. The intervening values are ignored.

The second method to calculate an average annual growth rate addresses this concern. This method relies on regressing time against the natural logarithm of the series in question. This is known as a log-linear regression. The specified equation is then

$$LN(Region\ ZHVI_t) = \beta_0 + \beta_1 * t + \varepsilon$$

where t is the year of observation and ε is an error term assumed to be identically and independently distributed (iid). In this form, the coefficient β_1 estimates the average annual growth rate of ZHVI. Using Ordinary Least Squares (OLS) regression we can estimate β_1 for each of our regions. Table 3 below shows the annual growth estimates for each region using both methods.

Table 3. ZHVI Average Annual Growth Rates by Geography, 2000-2023

Region	Geometric Mean	Log-Linear Regression
Mendocino County	4.52%	3.62%
Bay Area	5.06%	4.22%
California	5.84%	4.08%
Pacific Region	5.71%	4.09%
Western Region	5.60%	4.03%

With both methodologies, Mendocino County has the lowest average annual growth rate of ZHVI. California has the highest geometric growth rate while and the Bay Area has the highest log-linear growth rate of ZHVI. The regions with the closest ZHVI growth rates to Mendocino are the Bay Area (Geometric) and the Western Region (Log-Linear).

The final means by which we can compare home values in Mendocino County to the other regions is though regression analysis. We specify the following regression model

$$Mendocino\ ZHVI_t = \beta_0 + \beta_1 * Region\ ZHVI_t + \varepsilon$$

where t is time period and ε is an iid error term. This model specifies that the Mendocino ZHVI is dependent upon the ZHVI in either the Bay Area, California, Pacific, or Western Region. The results of these regressions are shown in Table 4 below.

Table 4. Regression Results of Mendocino ZHVI on Region ZHVI

Measure	Bay Area	California	Pacific Region	Western Region
Observations	24	24	24	24
R^2	0.9485	0.9474	0.9530	0.9453
ANOVA F Value (Significance)	404.78 (1.18×10^{-15})	396.43 (1.18×10^{-15})	445.80 (4.28×10^{-16})	380.54 (2.24×10^{-15})
β_0 (Std Error)	70,890 (15,399)	75,836 (15,325)	72,155 (14,621)	73,148 (15,770)
β_0 t Stat (p Value)	4.604 (0.0001)	4.949 (0.0001)	4.935 (0.0001)	4.638 (0.0001)
β_1 (Std Error)	0.4248 (0.0211)	0.6984 (0.0351)	0.7570 (.0358)	0.8583 (0.0440)
β_1 t Stat (p Value)	20.119 (1.18×10^{-15})	19.910 (1.46×10^{-15})	21.114 (4.28×10^{-16})	19.507 (2.24×10^{-15})

Like the 2016 study, we test the regression model assuming a zero intercept. (Even though the p-values are quite low.) To test this, we specified the following equation

$$Mendocino\ ZHVI_t = \beta_1 * Region\ ZHVI_t + \varepsilon$$

and estimated the equation again using OLS. The results are in Table 5 below.

Table 5. Regression Results of Mendocino ZHVI on Region ZHVI

Measure	Bay Area	California	Pacific Region	Western Region
Observations	24	24	24	24
R^2	0.9925	0.9917	0.9926	0.9920
ANOVA F Value (Significance)	3,035.62 (4.52×10^{-25})	2,763.13 (1.26×10^{-24})	3,100.84 (3.58×10^{-25})	2,840.50 (9.33×10^{-25})
β_1 (Std Error)	0.5168 (0.0094)	0.8624 (0.0164)	0.9243 (.0166)	1.0512 (0.0197)
β_1 t Stat (p Value)	55.096 (6.23×10^{-26})	52.566 (1.82×10^{-25})	55.685 (4.88×10^{-26})	53.296 (1.33×10^{-25})

The results in Table 5, when compared to the results in Table 4, show there is an across-the-board improvement in the model when the intercept is assumed to be zero.

When reviewing the results of this type of regression (Table 4 and Table 5) we want to keep in mind four questions:

- How much of the data does this model explain? R^2 shows (Table 5) that this model explains upward of 99% of the data for each region.
- Is this a good model? The ANOVA Significance answers this is a good model. All the models have great significance of greater than a 0.01 confidence level.
- What is the relationship between the dependent (Mendocino ZHVI) and independent (Other regions ZHVI) variables? $\boldsymbol{\beta_1}$ tells us the relationship between the variables is positive. We can also tell this by looking at the scatterplots in Tables 13 through 16. An imaginary line through the cluster of points has an upward slope.
- Do we have a good variable? (ZVHI) The t Stat p Value (6.23×10^{-26}) tells us we have a good variable because the value is less than 0.01.

The β_1 estimates above show the expected increase in Mendocino County ZHVI for every $1 increase in the corresponding region ZHVI. That is, for a $1 increase in Bay Area (Western Region) home prices we should expect a $0.52 ($1.05) increase in Mendocino County home prices.

Though we have found how estimated changes in regional ZHVI prices relate to Mendocino County on a dollar basis, we still do not know which region explains the behavior of home prices in Mendocino County.

To directly test the growth of the ZHVI of Mendocino County against that of other regions, we can specify a different model of home prices. We can postulate the following model.

$$Mendocino\ ZHVI_t = Region\ ZHVI_t^{\beta_1} + \varepsilon$$

Taking the natural logarithm of this equation reveals the following functional form.

$$LN(Mendocino\ ZHVI_t) = \beta_1 * LN(Region\ ZHVI_t) + \varepsilon$$

This is known as a log-log regression model. Importantly, in this construction β_1 is the elasticity of the Mendocino ZHVI to the ZHVI of the Region. Stated differently:

$$\beta_1 = \frac{Percentage\ Change\ in\ Mendocino\ ZHVI}{Percentage\ Change\ in\ Region\ ZHVI}$$

so β_1 tells us that for every 1% change in the ZHVI of the Region, what percentage change in the Mendocino ZHVI we can expect. The results from estimating the log-log regression with OLS are shown in Table 6 on the following page.

Table 6. Log-Log Regression Results of Mendocino ZHVI on Region ZHVI

Measure	Bay Area	California	Pacific Region	Western Region
Observations	24	24	24	24
R^2	0.9999	0.9999	0.9999	0.9999
ANOVA F Value (Significance)	537,123 (9.15×10^{-50})	550,244 (7.02×10^{-50})	730,758 (3.10×10^{-51})	690,708 (5.76×10^{-51})
β_1 (Std Error)	0.9533 (0.0013)	0.9916 (0.0013)	0.9967 (.0017)	1.0067 (0.0012)
β_1 t Stat (p Value)	732.887 (9.55×10^{-52})	741.784 (7.24×10^{-52})	854.844 (2.77×10^{-53})	831.089 (5.30×10^{-53})

All models are highly significant with very high R^2, ANOVA F test value and a parameter t-statistic. The β_1 parameter estimate indicates that for a 1% increase in the Bay Area ZHVI, the Mendocino County ZHVI increases by 0.953%. Alternatively, for a 1% increase in the Western Region ZHVI, the Mendocino County ZHVI increase by 1.007%.

The important distinction in this test is which elasticity is closer to a value of 1. An elasticity of 1 would show

$$Percentage\ Change\ in\ Mendocino\ ZHVI = Percetage\ Change\ in\ Region\ ZHVI$$

with simple algebraic reordering of the β_1 equation on page 23.

Table 7. Elasticity Estimates from Log-Log Regression of Mendocino County ZHVI on Region ZHVI (Summary Comparison of Table 6)

Geographies	Elasticity Estimate
Mendocino –Bay Area	0.9533
Mendocino –California CPI	0.9916
Mendocino – Pacific Region	0.9967
Mendocino – Western Region	1.0067

Table 7 shows that the elasticity of the Mendocino County ZHVI to the Pacific Region is closest to a value of 1. The Western Region is second closest, followed by California, and finally the Bay Area.

Last, we conducted an additional statistical test of the difference between the elasticity estimates of Mendocino – Pacific Region and Mendocino County – Western Region. The test assumes the true elasticity figures are equal, then determines the likelihood of observing the above estimates given that assumption. This test shows there is a 0.04% likelihood of observing the difference in elasticity estimates between the Pacific Region and the Western Region if the true values are the same.

All these findings indicate that either the Pacific or Western Region is the best fit for home values in Mendocino County.

To continue the analysis, we turn to the Housing and Urban Development Fair Market Rent (FMR) Data.

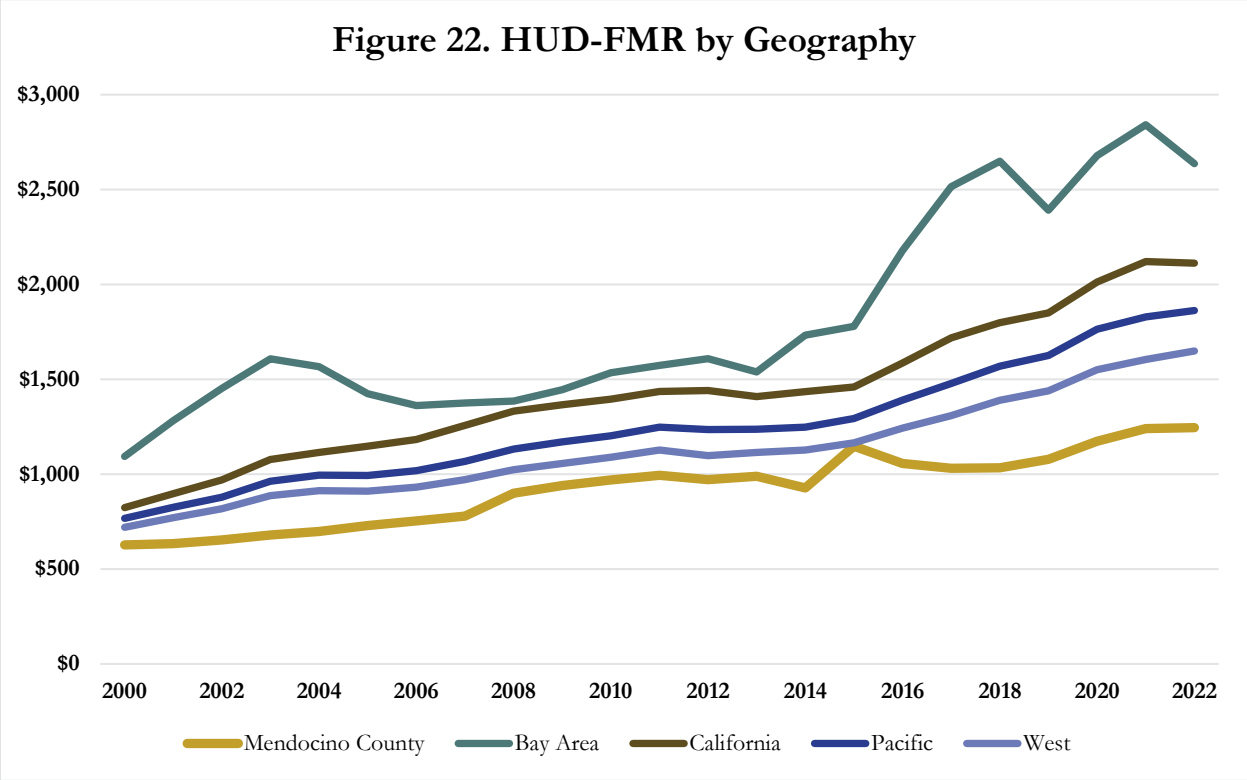
HUD Fair Market Rents

We repeat the ZHVI analysis using the FMR data series with one exception: U. S. Census Bureau County level population data is only available through calendar year 2022, so the FMR analysis uses the period of 2000 to 2022.

The HUD FMR data and corresponding documentation can be found at the FMR website at https://www.huduser.gov/portal/datasets/fmr.html. . The following quote from the FMR website outlines the purpose of the FMR data:

> "Fair Market Rents (FMRs) are used to determine payment standard amounts for the Housing Choice Voucher program, initial renewal rents for some expiring project-based Section 8 contracts, initial rents for housing assistance payment (HAP) contracts in the Moderate Rehabilitation Single Room Occupancy program (Mod Rehab), rent ceilings for rental units in both the HOME Investment Partnerships program and the Emergency Solutions Grants program, maximum award amounts for Continuum of Care recipients and the maximum amount of rent a recipient may pay for property leased with Continuum of Care funds, and flat rents in Public Housing units. The U.S. Department of Housing and Urban Development (HUD) annually estimates FMRs for Office of Management and Budget (OMB) defined metropolitan areas, some HUD defined subdivisions of OMB metropolitan areas, and each nonmetropolitan county. 42 USC 1437f requires FMRs be posted at least 30 days before they are effective and that they are effective at the start of the federal fiscal year (generally October 1). Fair Market Rents, as defined in 24 CFR 888.113 are estimates of 40th percentile gross rents for standard quality units within a metropolitan area or nonmetropolitan county."

HUD produces FMR data for differing sizes of housing units, from Efficiency units to 4 Bedroom units. We focus our analysis on the 2 Bedroom FMR. Figure 22 below shows the FMR figures for each region.



Next, we examine correlation coefficients in Table 8 for the best fit of region.

Table 8. Correlation Coefficient of FMR for Geographies

Geographies	Correlation Coefficient
Mendocino – Bay Area	0.798963
Mendocino – California	0.939589
Mendocino – Pacific Region	0.936390
Mendocino – Western Region	0.936435

Figures 23 through 26 show the scatter diagram of Mendocino County FMR compared to each region. Figure 27 below shows the values of the correlation coefficient between Mendocino County and each region from 2000 to the reference year.

Figure 23. FMR, Mendocino v. Bay Area

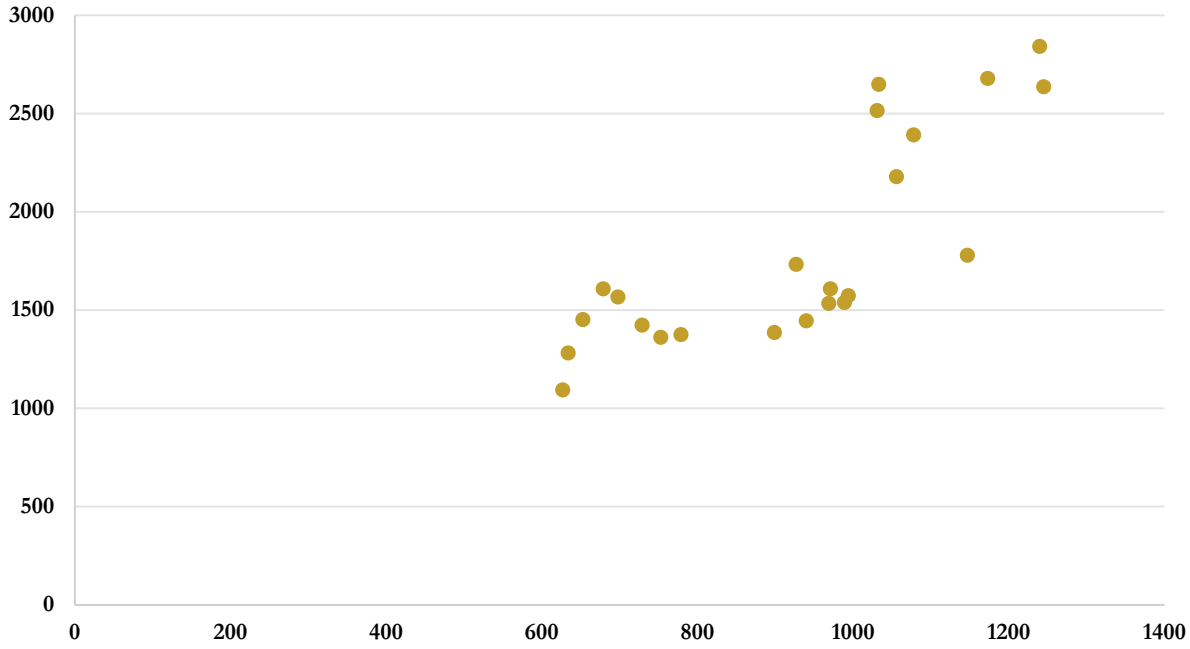


Figure 24. FMR, Mendocino v. CA

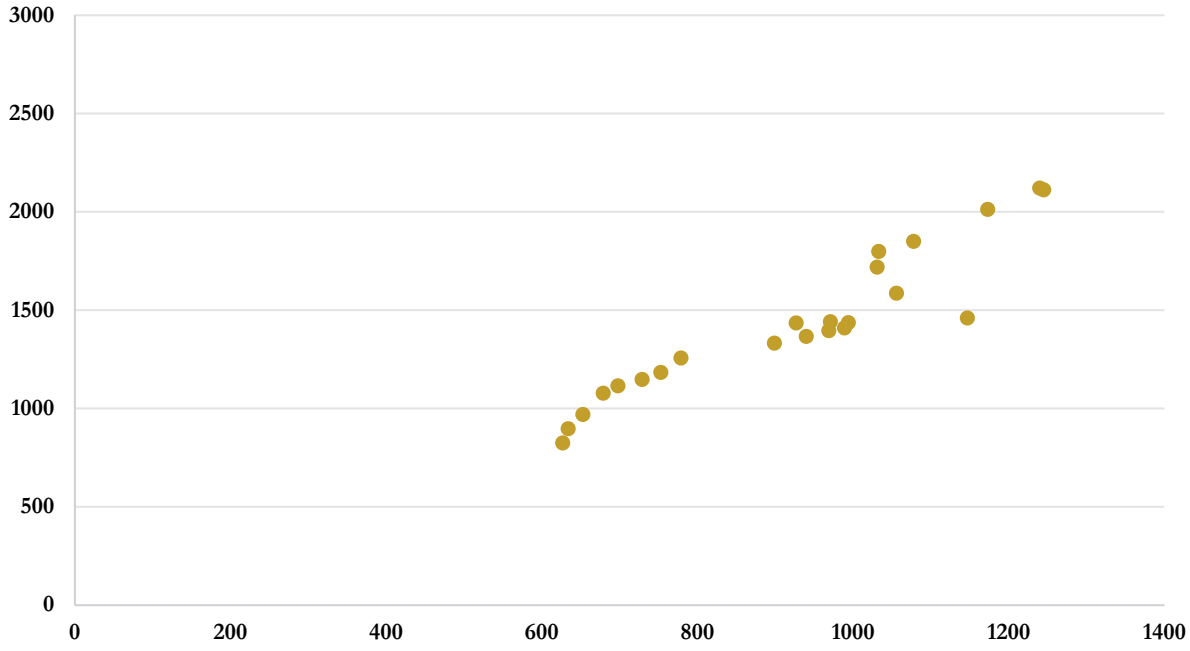


Figure 25. FMR, Mendocino v. Pacific

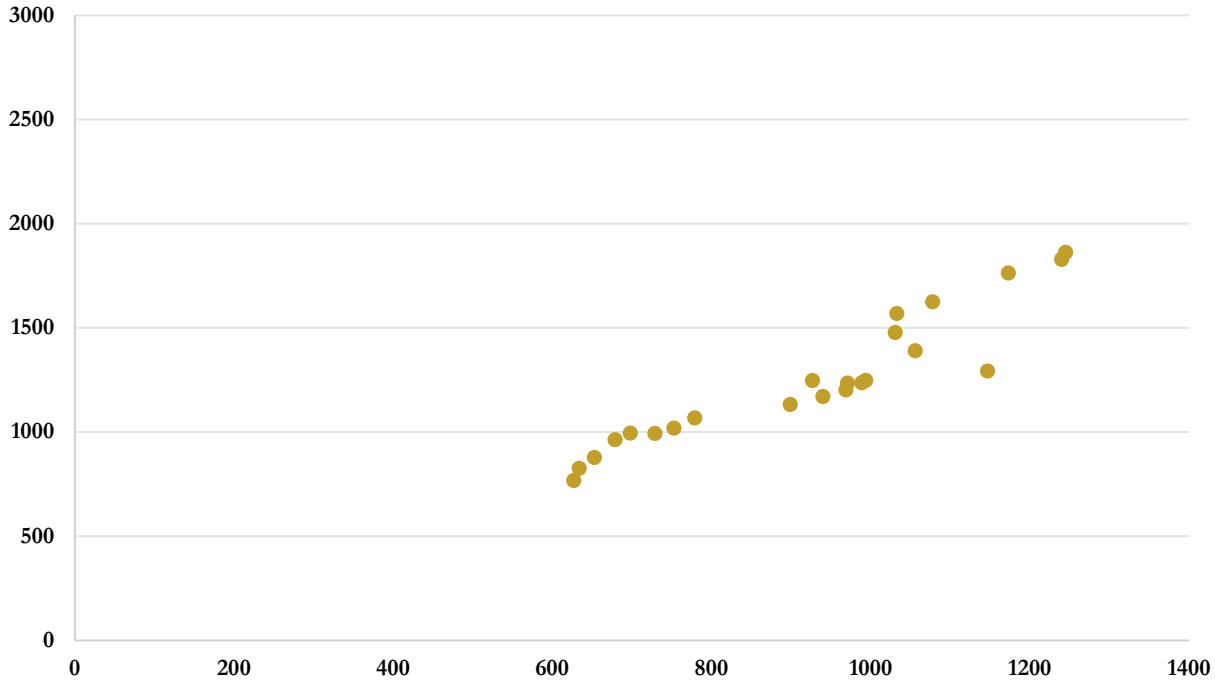


Figure 26. FMR, Mendocino v. West

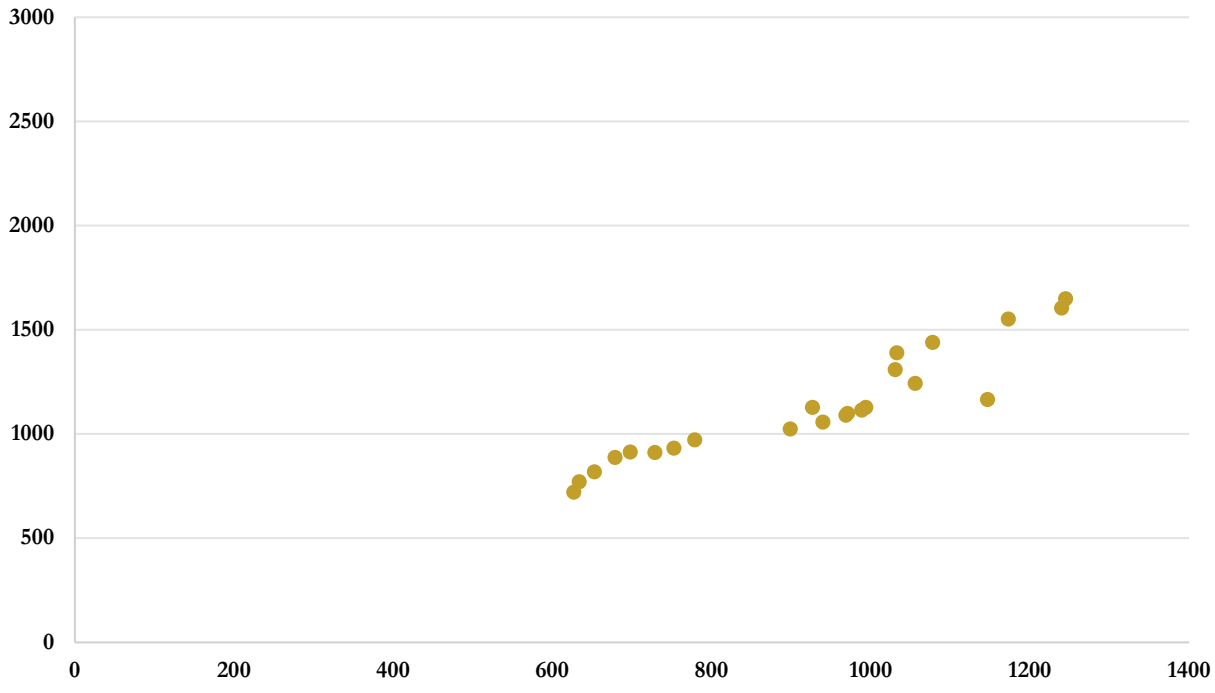


Figure 27. HUD-FMR Correlations, 2000 to End Year

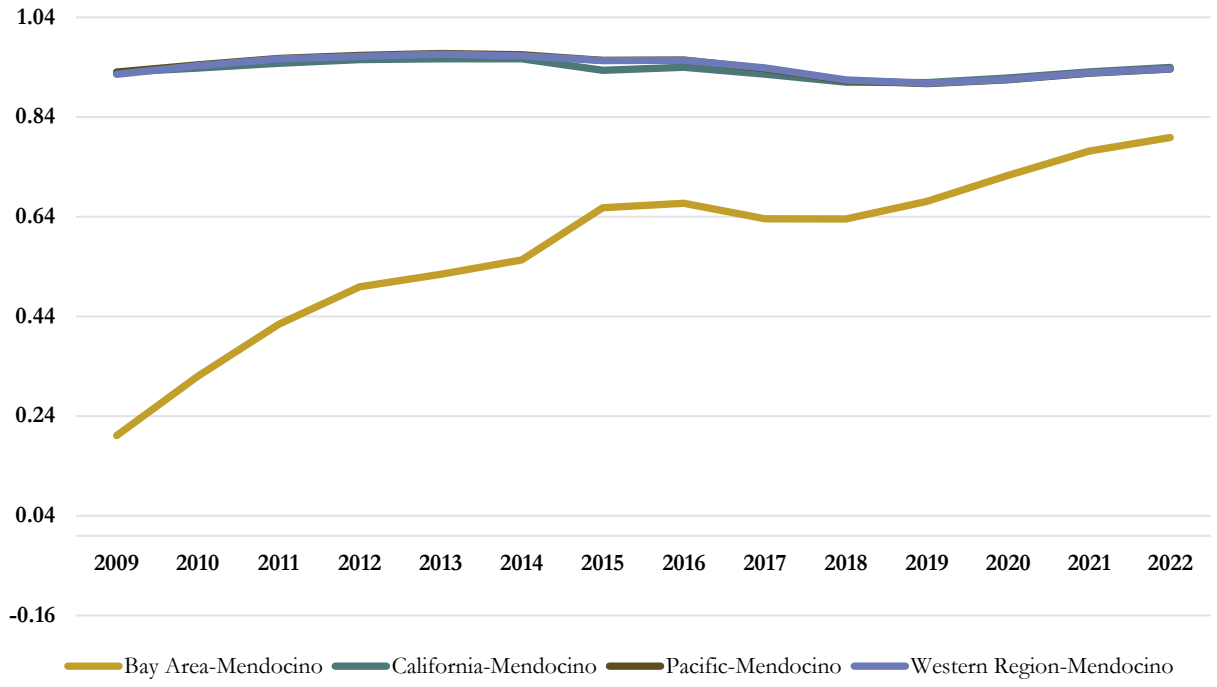
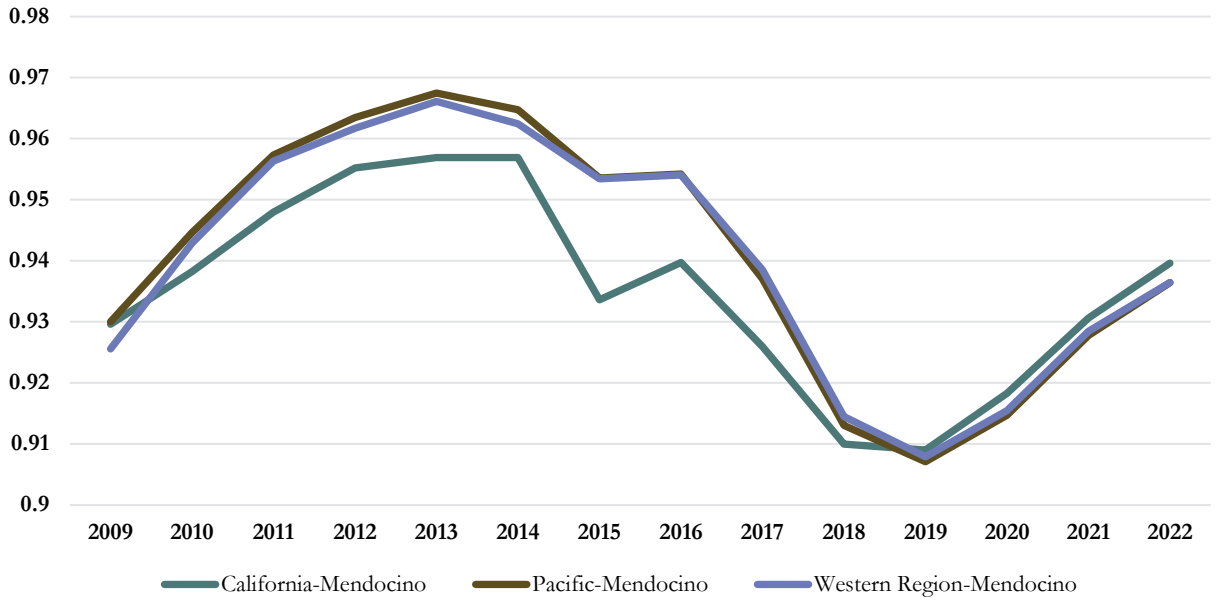


Figure 27 is difficult to evaluate since three series seem nearly identical with the given scale. To highlight the differences between these three series, Figure 28 below removes the outlier (Mendocino-Bay Area) and adjusts the scale.

Figure 28. HUD-FMR Correlations, 2000 to End Year



Next, we turn to the two estimates of the average annual rate of growth in the FMR by geography. Table 9 below presents the average annual growth rate as calculated by both the geometric mean methodology and the log-linear regression methodology. As a reminder, the log-linear regression growth estimate is less impacted by end point issues than is the geometric mean growth estimate.

Table 9. FMR Average Annual Growth Rates by Geography, 2000-2022

Region	Geometric Mean	Log-Linear Regression
Mendocino County	3.17%	3.11%
Bay Area	4.08%	3.72%
California	4.37%	3.76%
Pacific Region	4.11%	3.61%
Western Region	3.84%	3.34%

Table 9 shows that both the Western Region's growth rates are closer to Mendocino County than the other regions. The FMR growth rates for the Bay Area, California, and the Pacific Region are well above Mendocino County and the Western Region.

Finally, we turn to the log-log regression results to determine the elasticity of the Mendocino County FMR to the FMR in each comparable geography. These results are shown below in Table 10.

Table 10. Log-Log Regression Results of Mendocino FMR on Region FMR

Measure	Bay Area	California	Pacific Region	Western Region
Observations	23	23	23	23
R^2	0.9997	0.9999	0.9999	0.9999
ANOVA F Value (Significance)	43,835 (2.39×10^{-36})	177,741 (9.90×10^{-43})	185,168 (6.44×10^{-43})	202,257 (2.55×10^{-43})
β_1 (Std Error)	0.9116 (0.0044)	0.9405 (0.0022)	0.9581 (.0022)	0.9720 (0.0022)
β_1 t Stat (p Value)	209.368 (8.51×10^{-38})	421.595 (1.75×10^{-44})	430.312 (1.19×10^{-44})	449.730 (4.24×10^{-45})

The critical component from Table 10 for this analysis is the estimate of β_1. These estimates are shown in Table 11 below for ease of comparison.

Table 11. Elasticity Estimates from Log-Log Regression of Mendocino County FMR on Region FMR (Summary Comparison of Table 10)

Geographies	Elasticity Estimate
Mendocino –Bay Area	0.9116
Mendocino –California	0.9405
Mendocino – Pacific Region	0.9581
Mendocino – Western Region	0.9720

Again, we can ask which elasticity is nearest to the value of 1. This value is important as it indicates that the percentage change in FMR for Mendocino County equals the percentage change in FMR for the corresponding geography. Table 11 shows the elasticity moves closer to the critical value as one moves down the table. The Western Region produces an elasticity estimate closer to 1 than does the Pacific Sub-Region.

We conducted a final statistical test of the difference between the elasticity estimates of Mendocino – Pacific Region and Mendocino County – Western Region. The test assumes the true elasticity figures are equal, then determines the likelihood of observing the above estimates given that assumption. This test shows there is a 1.80% likelihood of observing the difference in elasticity estimates between the Pacific Sub-Region and the Western Region if the true values are the same. The statistical evidence suggests the Western Region elasticity is significantly closer to the critical value of 1 than is the Pacific Sub-Region elasticity.

Conclusion

This review focuses the question: which Bureau of Labor Statistics region, the Bay Area, California, the Pacific Region, or the Western Region, better reflects the rate of inflation in Mendocino County?

First, we examined the CPI for the Bay Area, California, and the Western regions. By decomposing the regional indices, we were able to show that differences in housing prices are (or remain) the major contributor of the differences between the Bay Area CPI, California CPI, and the Western Region CPI. This result allows us to use indicators of home prices as a proxy for the total difference in CPI.

Next, we identified the Zillow Home Value Index and the U.S. Department of Housing and Urban Development Fair Market Rents as two data sources related to the cost of housing with coverage of all five regions: Mendocino County, the Bay Area, California, the Pacific Region, and the Western Region. Population Weighted series were constructed for all regions as values of those specific geographies were not available.

Finally, we conducted three separate tests to determine whether the Mendocino County ZHVI (FMR) behaved more like the ZHVI (FMR) of each region. Those tests were: correlation coefficients, average annual growth rate comparison, and regression analysis. The tests showed in the case of ZHVI data that the Pacific or Western regions are most comparable to housing costs in Mendocino County. The tests of FMR show the Western region is most comparable to housing costs in Mendocino County.

Thus, since we have shown that differences in housing costs serve as a proxy for differences in inflation between the regions, and since housing costs in Mendocino County behave more similarly to housing costs in the Western Region, we conclude that the Western Region CPI is a better indicator of inflation in Mendocino County than the other regions. Accordingly, we recommend the Mendocino County Employees Retirement Association adopt the Wester Region CPI for granting Cost of Living Adjustments to retirees in 2025 and the future.