Mendocino County Employees Retirement Association

Determining the Appropriate Region for Cost of Living Adjustments for Mendocino County Employees Retirement Association: An Empirical Approach

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Determining the Appropriate Region for Cost of Living Adjustments for Mendocino County Employees Retirement Association: An Empirical Approach[1]

Executive Summary

The MCERA Board authorizes an annual Cost of Living Adjustment (COLA) to retirees based on a Consumer Price Index for All Urban Consumers produced by the Bureau of Labor Statistics. Since 1971, the MCERA Board has utilized the Bay Area CPI in granting the COLA.

The guiding statute directs the Board to use the CPI-U for the region in which the County Seat is located. Mendocino County is outside, but bordering, the Bay Area. Legal Counsel provided direction that the Board has authority to choose the region it feels most accurately reflects the rate of inflation in Mendocino County.

This research seeks to address the question of whether the Bay Area CPI or the Western Region CPI best reflects the rate of inflation in Mendocino County. To answer this question two different lines of analysis are required.

First, we review the differences in the CPI for the Bay Area and the Western Region. This analysis focuses on decomposing the difference between the two regions to determine the underlying cause for the total difference. This decomposition shows that differences in the cost of housing explain more than 100% of the difference in the Bay Area and Western Region CPI. This allows the use of a cost of housing measure as a proxy for the CPI difference.

Second, we examine cost of housing measures in Mendocino County, the Bay Area and the Western Region. For this analysis we utilize two data sets: the Zillow Home Value Index (ZHVI) data which is an estimate of the median home value for various geographies and the Fair Market Rental Rate produced by the United States Department of Housing and Urban Development. Neither data series is available for the Bay Area nor the Western Region, so we create a population weighted measure for those regions.

Comparing Mendocino County to the Bay Area and the Western Region reveals that both home values and rents in Mendocino County behave more like the comparative measure in the Western Region than the Bay Area. The result is robust across several different statistical tests.

Thus, the recommendation to the MCERA Board is that the COLA in 2017, and subsequent years, be calculated based on the Western Region CPI.

[1] The author would like to thank the Board of Retirement for their support of this work. It is greatly improved from an earlier version based on questions and comments from the Board. Additionally, Abraham Rawls provided capable research assistance that greatly aided in the creation of this work.

Introduction

In February 2015, the Board of Retirement (Board) of the Mendocino County Employees Retirement Association (MCERA) considered the annual cost of living adjustment (COLA) for its retirees. The COLA is an increase in retiree annuities designed to ensure those annuities maintain their real, or after inflation, value.

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. (Emphasis Added)

Since the adoption of the COLA in1971, MCERA has utilized the Bureau of Labor Statistics ("BLS") Consumer Price Index for All Urban Consumers ("CPI-U") for the San Francisco-Oakland-San Jose region ("Bay Area"). This region consists of 10 counties in the area including: Alameda, Contra Costa, Marin, Napa, San Mateo, San Francisco, Santa Clara, Santa Cruz, Solano and Sonoma (see Map 1.).

The Bay Area is the only regional CPI in Northern California produced by the BLS, so Mendocino County is not included in any such BLS produced CPI estimate. The previous decision to use the Bay Area CPI-U as the basis for the MCERA COLA appears reasonable since the area is the closest region to Mendocino County, which actually borders the region.

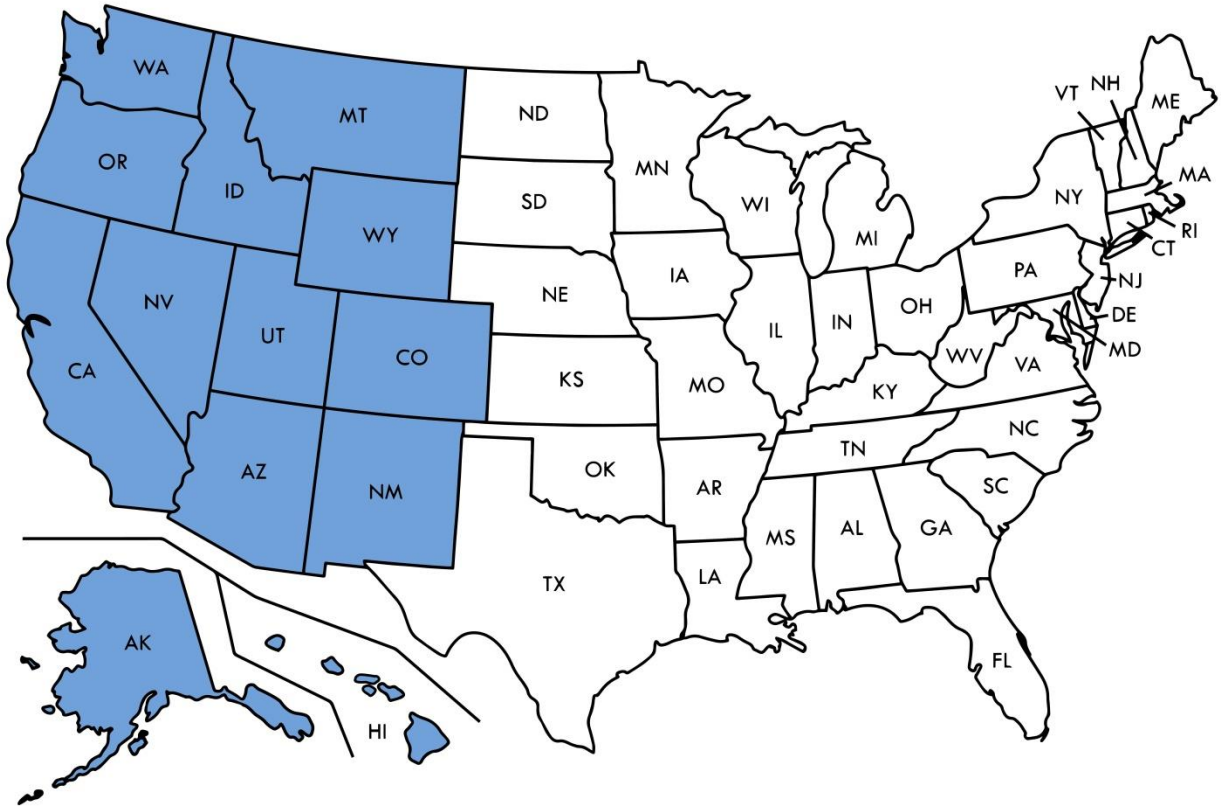
At the February 2015 MCERA Board meeting, a question was posed as to whether the Bay Area CPI-U was the appropriate basis for the MCERA COLA. After much discussion and debate, the Board took action in March 2015 to grant the COLA based on the Bay Area CPI-U. When the 2016 COLA came before the Board in February 2016, the appropriateness of the Bay Area was again questioned.

Map 1. San Francisco – Oakland – San Jose Area (Bay Area)

Staff presented information to the Board at the March 2015 and February 2016 meeting regarding other 1937 Act Plans that have a COLA as part of their plan. Those findings were that 10 of the 20 1937 Act Plans are inside of a local region as defined by the BLS and all of these plans use the local CPI-U.

Of the 10 1937 Act plans that are outside of a BLS defined local area, 8 use the closest local area and 2 use the CPI-U for the Western Region as defined by the BLS. The Western Region is comprised of 13 states including: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming (See Map 2.).

Map 2. Western United State Region (Western Region)



Most interesting of the plans is Fresno County because they changed from the Bay Area CPI-U to the Western Region CPI-U in 2006. At the time of the change in Fresno County, the actuary for the plan identified three questions to consider before changing the region. Those questions were:

1. Does the Board have the authority to change the region?
2. Which region CPI-U best estimates the inflation rate in the County?
3. Which region CPI-U provides the most stability in the plan sponsor contribution rates?

Fiduciary counsel to Fresno County provided an opinion on the first question, stating that the Board has plenary authority for the plan; and, as such, clearly has the authority to change the region as long as the decision is not arbitrary and is based on the answer to question 2.

Question 3 above is not pertinent for MCERA since the contribution rates are determined based on the assumed inflation rate, which is also the assumed COLA rate. Since contribution rates are based on assumed rates, the contributions should be unaffected by the region used to measure inflation.

Based on the above, staff made two recommendations to the Board at the February 2016 meeting:

1. Approve the 2016 COLA using the Bay Area CPI-U in accordance with the historical practice of the Board, and
2. Direct staff to commission or conduct research and empirical analysis to address question 2 for Mendocino County.

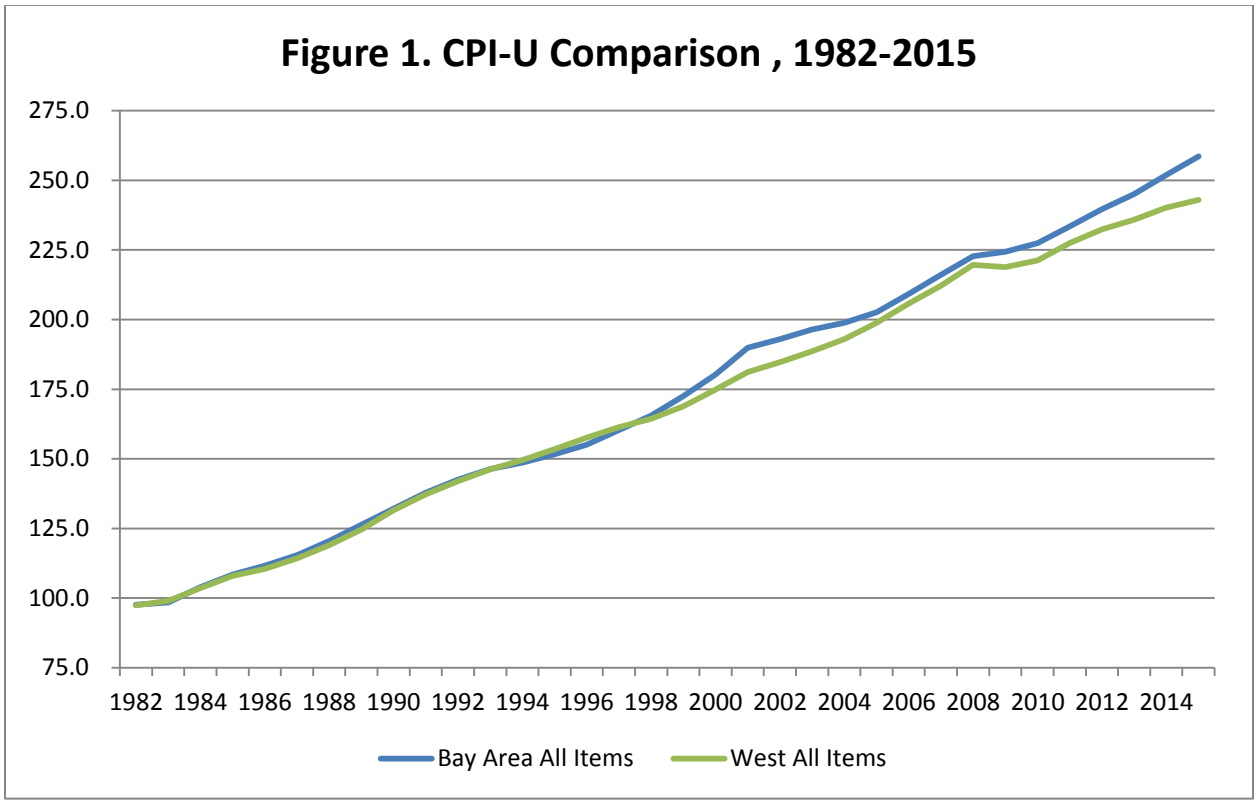
The MCERA Board requested this research be completed in advance of the February 2017 Board meeting, when the next COLA would be considered. We next turn to this analysis.

Analysis

Consumer Price Index

As a precursor to the analysis, we need to review some aspects of the Consumer Price Index. The Consumer Price Index for All Urban Consumers ("CPI-U") is the most popular tool for estimating inflation. The CPI-U is calculated by the Bureau of Labor Statistics ("BLS"), a federal government agency within the Department of Labor.

Figure 1 below shows the CPI-U for the Bay Area and the Western Region. Both series are indexed such that the average values between 1982 and 1984 are equal to 100. As the figure clearly shows, the CPI-U for the Bay Area is significantly higher than the CPI-U for the Western Region.

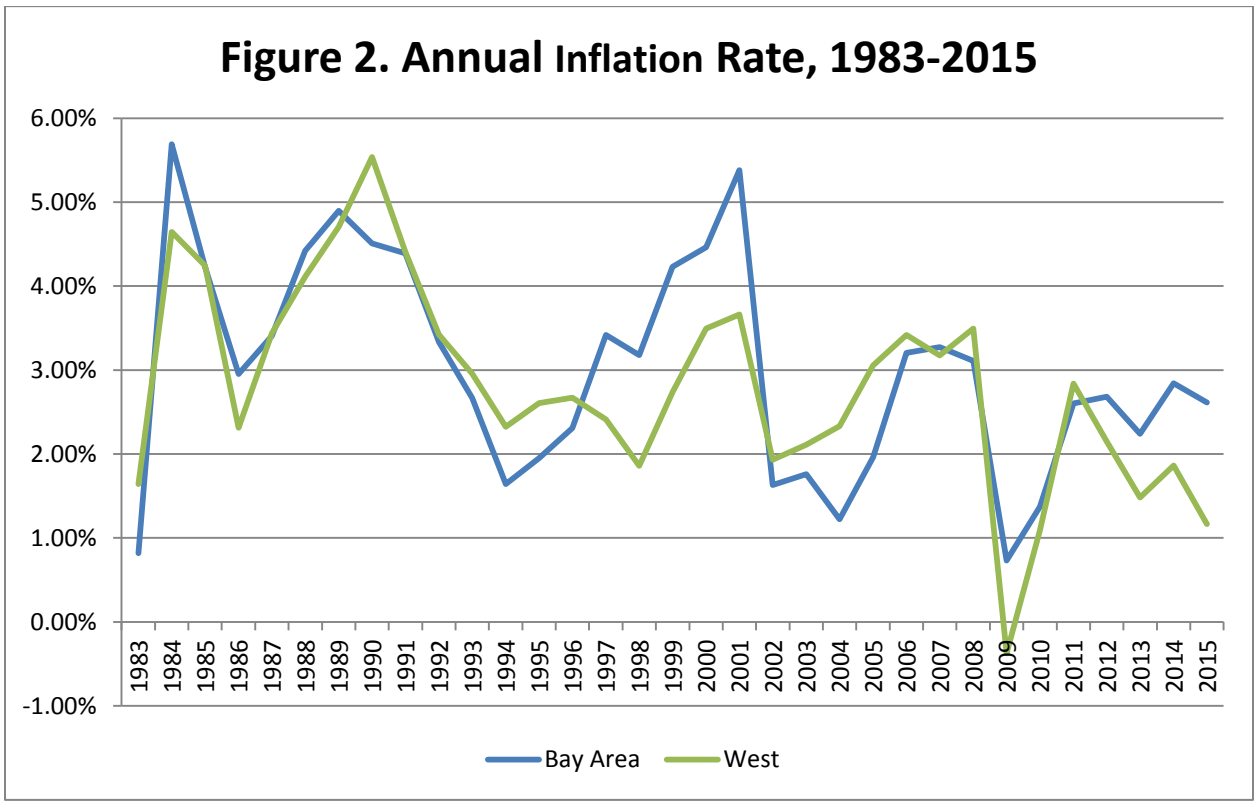


While there has been much debate in the past decades as to the accuracy of the CPI-U for measuring inflation, we will not touch on that debate as the law clearly requires MCERA use the CPI-U as the basis for the provision of its COLA. To condense notation throughout the remainder of this work, we will refer to the CPI-U as merely "CPI".

Using the CPI, 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 time period (i.e. 2015, 2014,…). Figure 2 shows the calculated inflation rate for the two areas based on the CPI in December of each year.



The CPI is also calculated for a number of 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 for each category are shown in the following graphs.

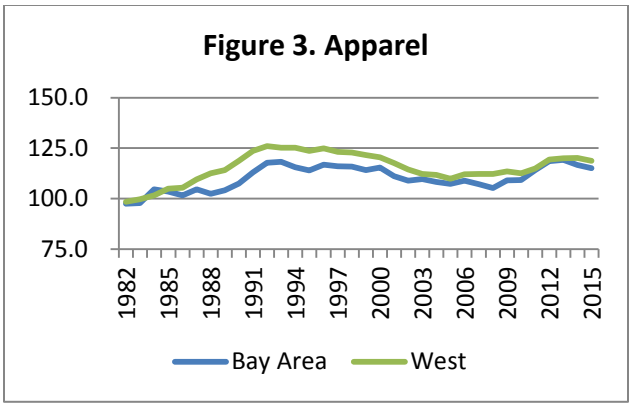


Figure 3. Apparel
150.0
125.0
100.0
75.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

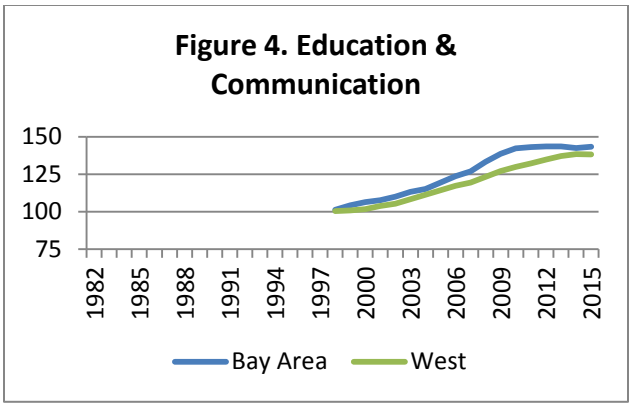


Figure 4. Education & Communication
150
125
100
75
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

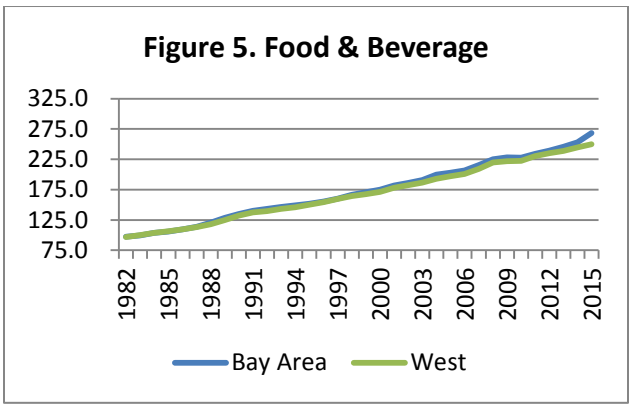


Figure 5. Food & Beverage
325.0
275.0
225.0
175.0
125.0
75.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

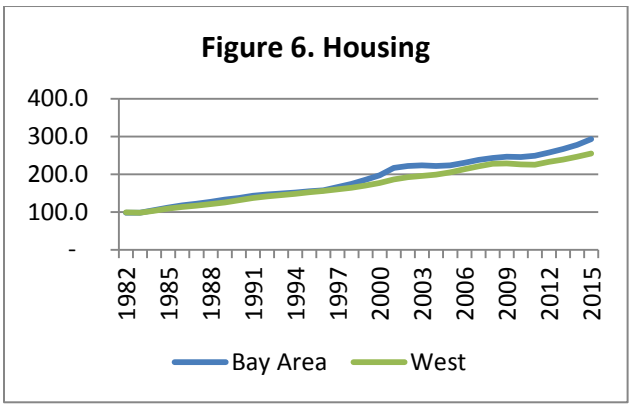


Figure 6. Housing
400.0
300.0
200.0
100.0
-
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

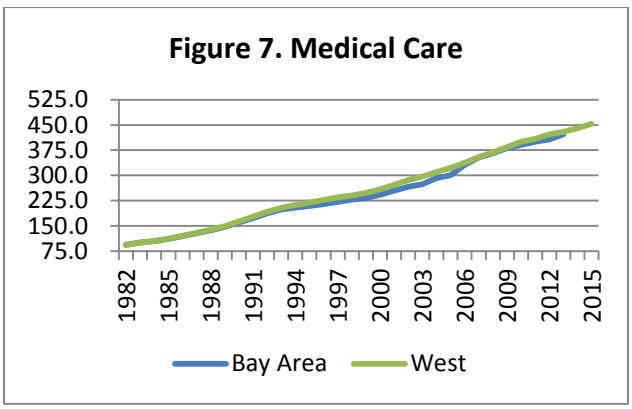


Figure 7. Medical Care
525.0
450.0
375.0
300.0
225.0
150.0
75.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

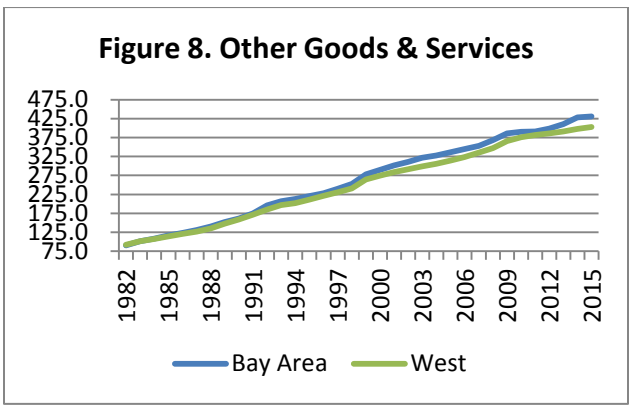


Figure 8. Other Goods & Services
475.0
425.0
375.0
325.0
275.0
225.0
175.0
125.0
75.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

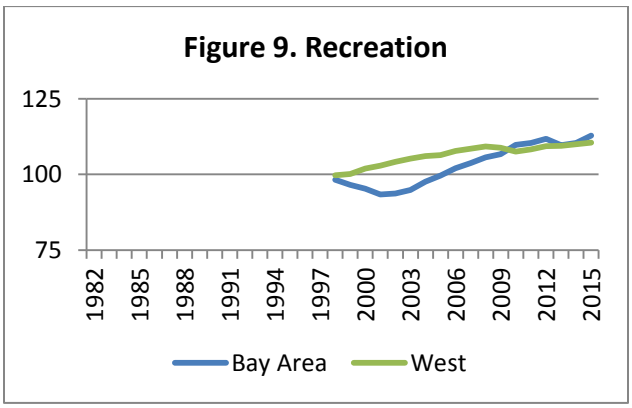


Figure 9. Recreation
125
100
75
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

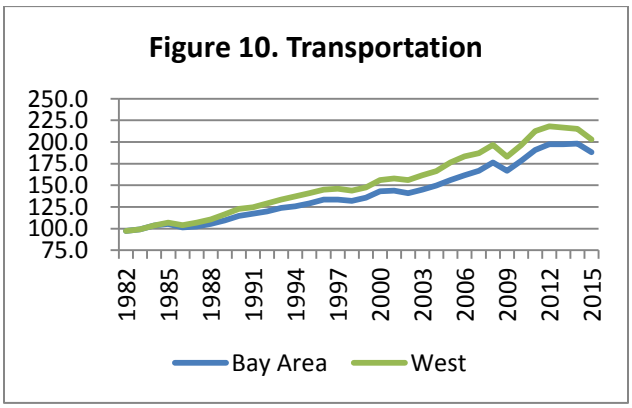


Figure 10. Transportation
250.0
225.0
200.0
175.0
150.0
125.0
100.0
75.0
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
Bay Area
West

To measure the differences between the CPI for the Bay Area and Western Region, we utilize 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. This is also known as the squared Euclidean distance formula and it provides a measure of the similarity of two data 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 – 2015

Category	Similarity Index
Total	977.95
Apparel	1,275.68
Education and Communication	885.63
Food and Beverage	889.13
Housing	10,451.31
Medical Care	3,802.76
Other Goods and Services	7,504.71
Recreation	576.69
Transportation	6,503.76

The Similarity Index values here clearly show that the category in which the Bay Area and the Western Region CPI most differ is the major category 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. To drill down further, we can examine the sub-category Shelter.

As the name indicates, Shelter involves only the expense involved in obtaining a shelter or dwelling. It excludes the cost of Utilities such as electricity, heating oil and natural gas for heating. Table 2 below presents the Similarity Index between the Bay Area and Western Region in total and for the category Housing as well as its major sub-category Shelter.

Table 2. Bay Area – Western Region CPI Similarity Index, 1982-2015

Category	Similarity Index
Total	977.95
Housing	10,451.31
Shelter	15,179.72

Tables 1 and 2 indicate that the cost of housing is a significant cause of the difference in the CPI between the Bay Area and the Western Region. Given this information, the next questions is what share of the difference in total CPI between the Bay Area and the Western Region can be assigned to each major category. While the Similarity Index is a very useful tool for measuring similarity, it is decidedly less useful for addressing this question.

To quantify the impact of the various categories on the total difference in the CPI between the Bay Area and the Western Region, we construct a new CPI for both areas using the category CPI and the Importance Factor. The Bureau of Labor Statistics produces the Importance Factor as part of the CPI series.

The Importance Factor is a measure of the significance of each category in the total CPI. For example, in 2015 the importance factor for Housing was 41.8, whereas the corresponding factor for Apparel was 3.1. The sum of the importance factors for all 8 categories is 100, so if each importance factor is divided by 100 the result is a percentage.

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 0.998 for both the Bay Area and the Western 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 two regions and attribute the difference in total to the categories. This is accomplished via the formula

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

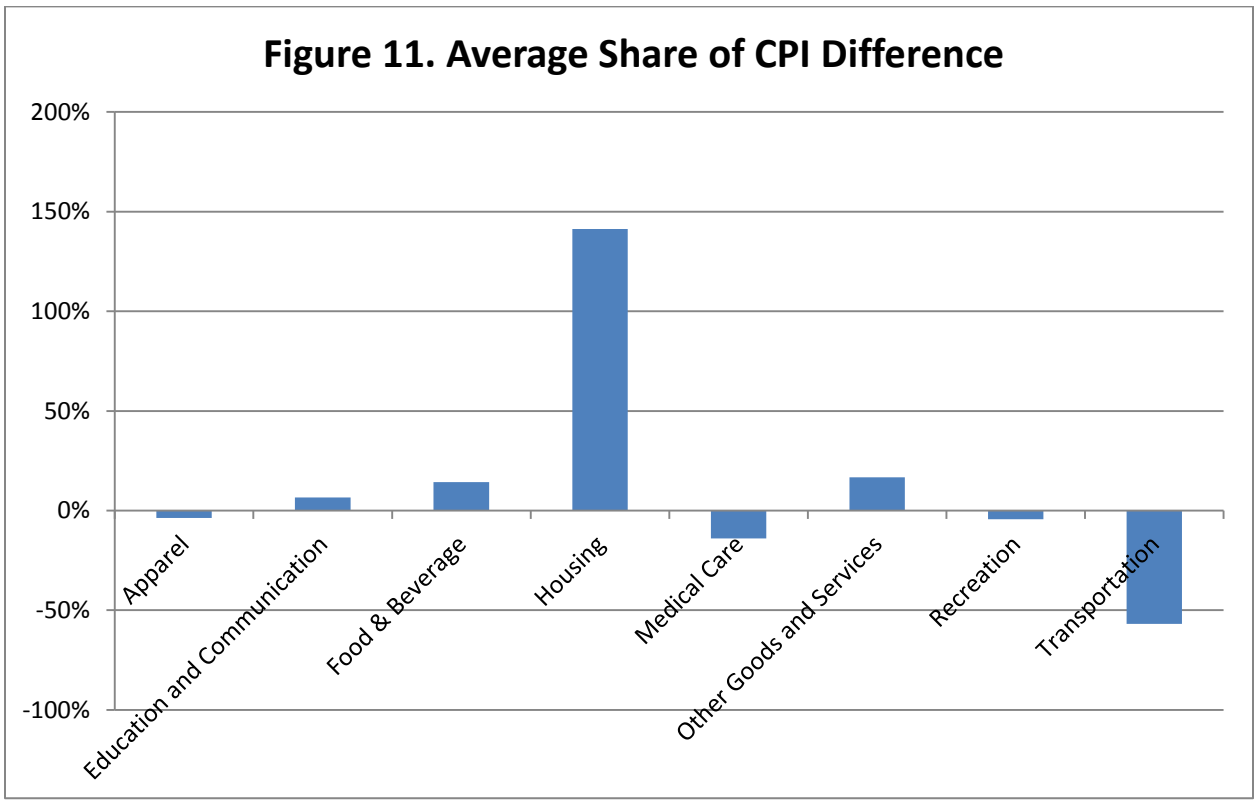
where c is the Category. As a test, if the sum

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

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*$_{c,t}$ by category over the time period 1998 – 2013 as this is the period over which we have comparable data. Taking the average over time provides a more accurate indication of how important each category is in explaining the difference as extreme values in either direction are mitigated.

This average figure then indicates the percent of the total difference between the Bay Area CPI and the Western Region CPI that is caused by the differences in the corresponding CPI for each category. These averages are shown in Figure 11 below.



As the figure shows, the categories Apparel, Medical Care, Recreation and Transportation negatively contribute to the difference between the Bay Area CPI and the Western Region CPI. Stated another way, these four categories serve to lessen the difference between the Bay Area CPI and the Western

Region CPI. Alternatively, the categories Education and Communication, Food and Beverage, Housing and Other Goods and Services all increase the difference between the Bay Area CPI and the Western Region CPI.

Most notable in Figure 11 is the category Housing which accounts for 141% of the difference between the Bay Area CPI and Western Region CPI. While not shown in the figure, the sub-category Shelter is responsible for 133% of the total difference.

This is a significant result as it indicates the difference in the cost of obtaining shelter is the sole cause for the Bay Area CPI exceeding the Western Region CPI. This means that we can use the cost of shelter as a proxy for the difference between the CPIs. Using the cost of shelter as a proxy affords additional avenues of research since more data is available on cost of shelter.

As a brief review of the issues, the overriding question is whether the Bay Area CPI or the Western Region CPI is a better indicator of the rate of inflation in Mendocino County. There is no BLS produced CPI measure on which Mendocino County can rely.

The analysis above shows that the differences between the Bay Area CPI and the Western Region CPI are driven by differences in the cost of housing (we are now changing to use "housing" to generally mean the cost of purchasing a home). The next step in the analysis is to examine the cost of housing in Mendocino County, the Bay Area and the Western Region.

Cost of Housing

We utilize two different data series to measure the cost of housing in the three Geographies. 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 and the Western Region, we searched for time series data that covered the three regions. The best alternative identified was the Zillow Home Value Index (ZHVI) from www.zillow.com. For a discussion of the methodology used to create the index see *Zillow Home Value Index: Methodology* available at the website http://www.zillow.com/research/zhvi-methodology-6032/.

As explained in the Introduction of the paper

> "Each Zillow Home Value Index (ZHVI) is a time series tracking the monthly median home value in a particular geographical region. In general, each ZHVI time series begins

in April 1996. We generate the ZHVI at seven geographic levels: neighborhood, ZIP code, city, congressional district, county, metropolitan area, state and the nation."

The ZHVI series for Mendocino County spans from 1998 to current. Accordingly, we restrict our analysis to the period from 1998 – 2015. We also average the ZHVI series in each area over the twelve months of each calendar year for the analysis.

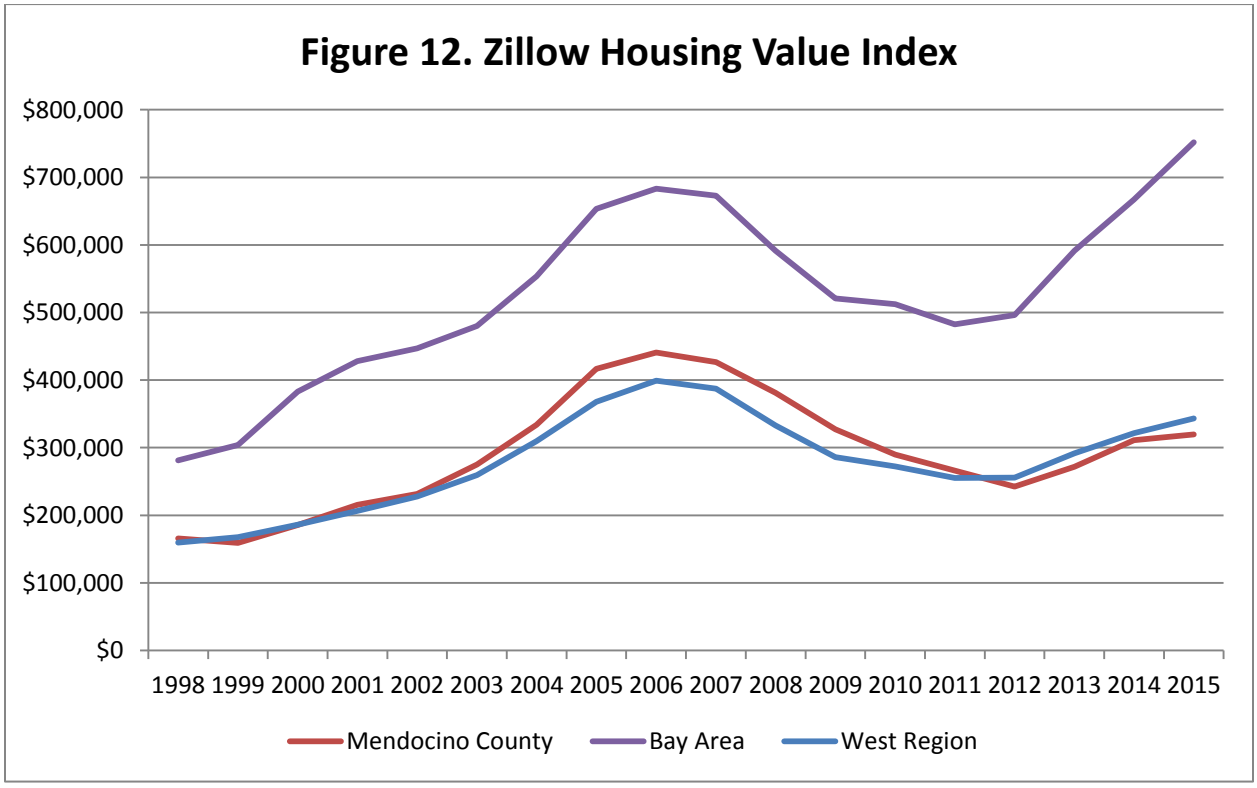
The ZHVI series addresses a number of issues involved in creating an index of home values and the methodology utilized to create the ZHVI series is robust. One issue we have to address is obtaining a corresponding ZHVI for the different regions.

As stated above, there is a ZHVI for Mendocino County, but the ZHVI is not available for the Bay Area or the Western Region. The ZHVI is available for the 10 counties in the Bay Area and for the 13 states in the Western Region.

So we can create a population weighted ZHVI

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

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 12 below shows the Mendocino ZHVI and the Population Weighted ZHVI for the Bay Area and Western Region from 1998 – 2015.



It is important to remember here that the ZHVI levels are not important. What does matter for our analysis is the comparable rate of growth (or slope of the curve) of each ZHVI over time. While Mendocino County is closer to the Western Region above in terms of levels, we need further analysis to determine whether the slope of the Mendocino County curve is closer to that of the Bay Area or the Western Region. Going forward we will drop the "Population Weighted" for the Bay Area and Western Region for convenience

There are a number of methods for assessing the "goodness of fit" between the Mendocino County ZHVI and the ZHVI for the Bay Area and Western Region. The first and simplest such method is to simply plot the series on a scatter plot for a visual examination. Figure 13 plots the Mendocino County ZHVI against the Bay Area ZHVI while Figure 14 compares Mendocino County against the Western Region.

The simple visual review seems to indicate that the Western Region ZHVI better fits the Mendocino County ZHVI. To quantify this 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 3 below shows the correlation coefficient for Mendocino ZHVI – Bay Area ZHVI and Mendocino ZHVI – Western Region ZHVI from 1998 to 2015.

Table 3. Correlation Coefficient of ZHVI for Geographies

Geographies	Correlation Coefficient
Mendocino – Bay Area	0.856868
Mendocino – Western Region	0.970941

The calculated values for the correlation coefficient confirm what the visual test of Figures 13 and 14 suggest. There is a stronger correlation between the Mendocino County ZHVI and the Western Region ZHVI than between the Mendocino County ZHVI and the Bay Area ZHVI.

Additional insight is found by examining the correlation coefficients over time. Figure 15 below shows the correlation coefficient for the two comparisons from 1998 to the year indicated in the figure. That is, the value in the figure for 2011 shows the correlation coefficient from 1998 to 2011 between the ZHVI for the two geographies.

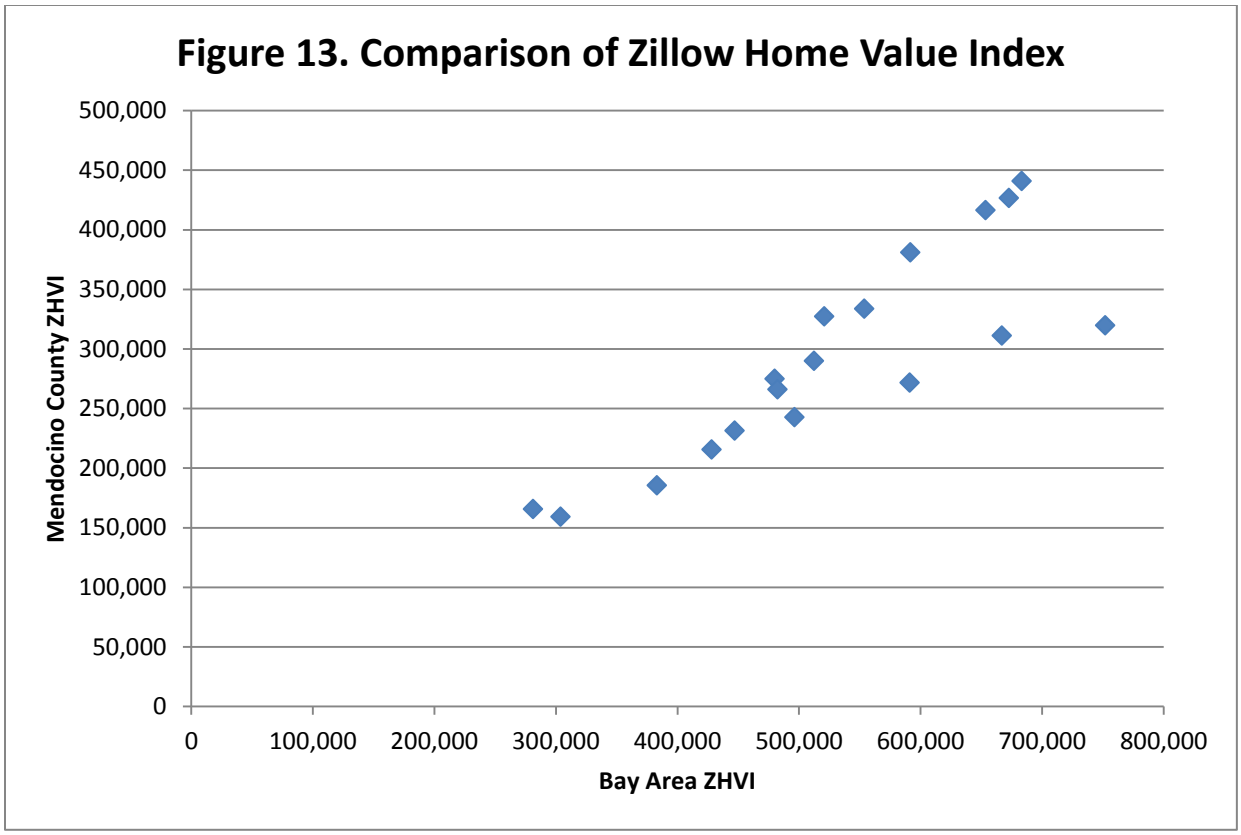


Figure 13. Comparison of Zillow Home Value Index
Mendocino County ZHVI
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
100,000
200,000
300,000
400,000
500,000
600,000
700,000
800,000
Bay Area ZHVI

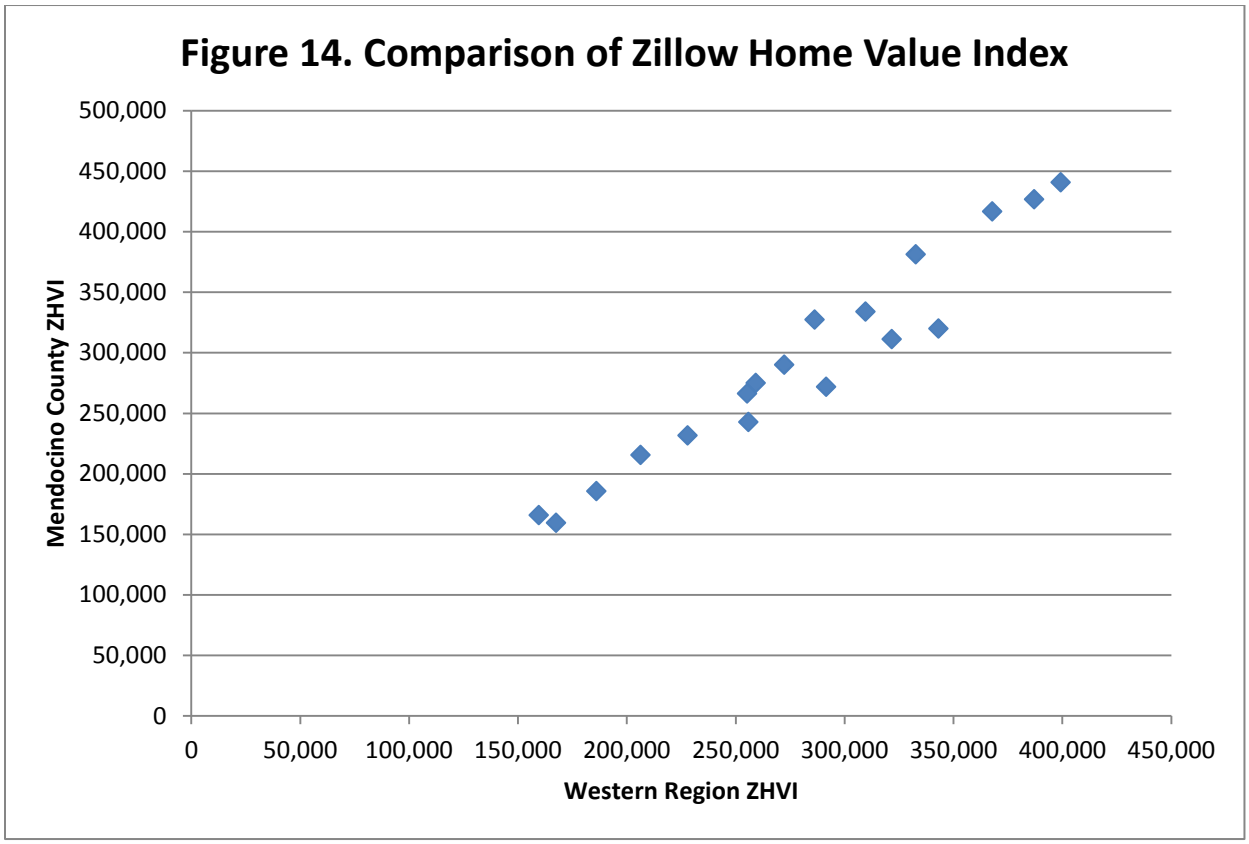
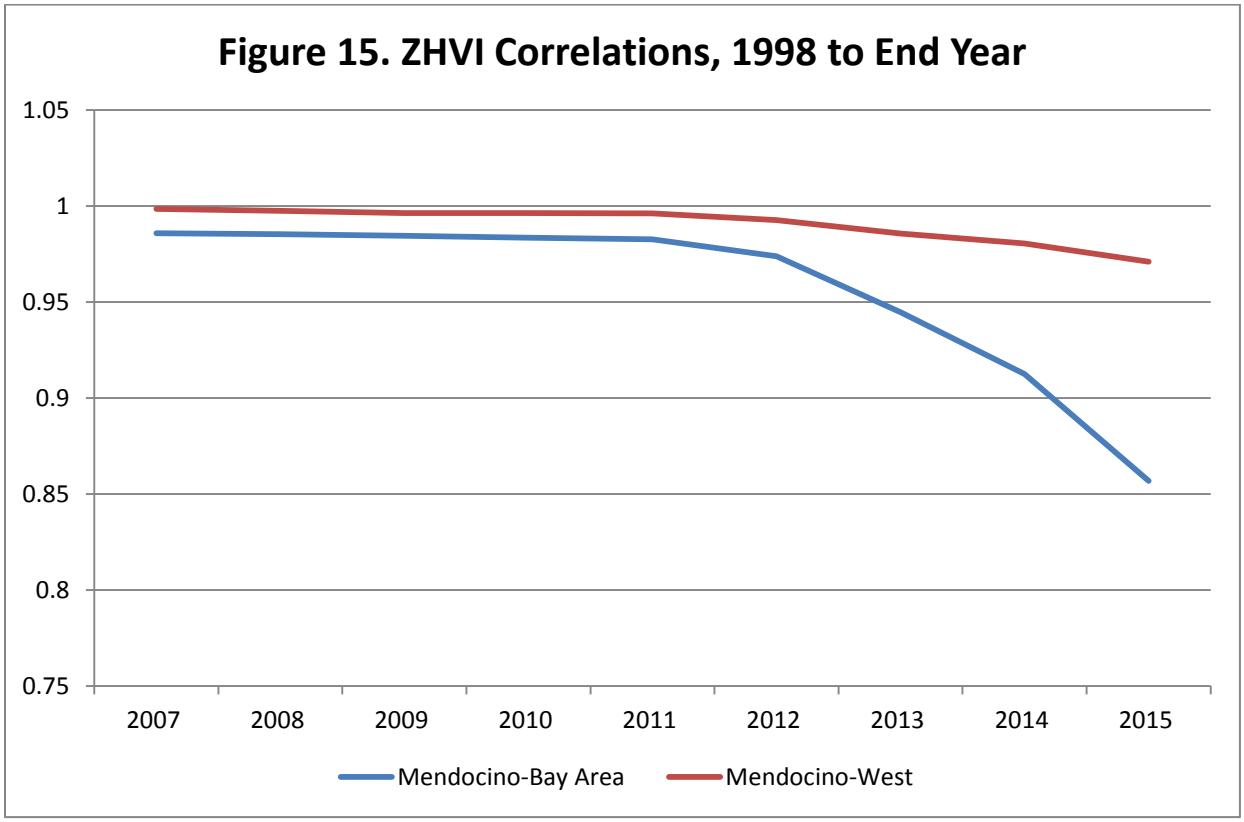


Figure 14. Comparison of Zillow Home Value Index
Mendocino County ZHVI
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
450,000
Western Region ZHVI

Figure 15 clearly shows that prior to 2012 there was very little difference between the two correlation coefficients. However, since 2012 there has been a significant degradation in the correlation between Mendocino Count ZHVI and the Bay Area ZHVI.

This result is also reflected in Figure 12 above where one can see the significant increase in the slope of the Bay Area ZHVI without a corresponding increase in the Mendocino County ZHVI. Thus, the comparison of Mendocino County ZHVI to the Bay Area ZHVI and Western Region ZHVI shows that Mendocino County has a stronger direct correlation to the Western Region than the Bay Area.



The next method by which we can compare ZHVI in Mendocino County to the ZHVIs in the Bay Area and the Western Region 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 above 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 sometimes referred to 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 construction, 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 4 below shows the annual growth estimates for each region using both methods.

Table 4. ZHVI Average Annual Growth Rates by Geography, 1998-2015

Region	Geometric Mean	Log-Linear Regression
Mendocino County	3.94%	2.96%
Bay Area	5.96%	3.75%
Western Region	4.60%	3.27%

With both methodologies, Mendocino County has the lowest average annual growth rate of ZHVI and the Bay Area has the highest average annual growth rate of ZHVI. As with the correlation coefficient, the measures of the annual average growth rate indicate the Western Region ZHVI is a better match to the Mendocino County ZHVI than is the Bay Area ZHVI.

The final means by which we can compare home values in Mendocino County to the Bay Area and the Western Region 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 or Western Region. The results of these regressions are shown in Table 5 below.

The relatively high p-values associated with the estimate for the intercept term, β_0 suggest the model may have a zero intercept. 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 6 below.

Table 5. Regression Results of Mendocino ZHVI on Region ZHVI

Measure	Bay Area	Western Region
Observations	18	18
R^2	0.7342	0.9427
ANOVA F Value (Significance)	44.20 (5.60×10^{-6})	263.36 (2.33×10^{-11})
β_0 (Std Error)	-4,381 (45,893)	-31,144 (20,543)
β_0 t Stat (p Value)	-0.095 (0.9251)	-1.516 (0.1490)
β_1 (Std Error)	0.5619 (0.0845)	1.1571 (0.0713)
β_1 t Stat (p Value)	6.648 (5.597×10^{-6})	16.228 (2.33×10^{11})

Table 6. Regression Results of Mendocino ZHVI on Region ZHVI, Zero Intercept

Measure	Bay Area	Western Region
Observations	18	18
R^2	0.9798	0.9950
ANOVA F Value (Significance)	825.84 (3.372×10^{-15})	3,404.88 (4.51×10^{-20})
β_1 (Std Error)	0.5541 (0.0193)	1.052 (0.0180)
β_1 t Stat (p Value)	28.737 (7.487×10^{-16})	58.351 (4.99×10^{-21})

The results in Table 6, when compared to the results in Table 5, show there is an across the board improvement in the model when the intercept is assumed to be zero.

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 $0.55 ($1.05) increase in Mendocino County home prices.

This result is interesting, but does not directly address the question of which region better explains the behavior of home prices in Mendocino County since we are examining ZHVI levels in this regression. We should expect a parameter estimate less than 1 when regressing Mendocino County ZHVI against Bay Area ZHVI since the level of home prices in the Bay Area are much higher than the level of home prices in Mendocino County.

To directly test the growth of the ZHVI of Mendocino County against that of the Bay Area and the Western Region, 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 7 below.

Table 7. Log-Log Regression Results of Mendocino ZHVI on Region ZHVI

Measure	Bay Area	Western Region
Observations	18	18
R^2	0.9999	0.9999
ANOVA F Value (Significance)	160,130.88 (1.950×10^{-33})	586,461.82 (6.026×10^{-38})
β_1 (Std Error)	0.9542 (0.0024)	1.003 (0.0013)
β_1 t Stat (p Value)	400.164 (3.168×10^{-35})	765.808 (5.12×10^{-40})

Both 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 0.954%. Alternatively, for a 1% increase in the Western Region ZHVI, the Mendocino County ZHVI increase by 1.003%.

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 above.

Given the values in Table 7, it is clear that the elasticity of the Mendocino County ZHVI to the Western Region ZHVI is closer to a value of 1 than is the elasticity of the Mendocino County ZHVI to the Bay Area ZHVI. So, the regression analysis above shows that the Western Region, once again, better explains home values in Mendocino County.

HUD Fair Market Rents

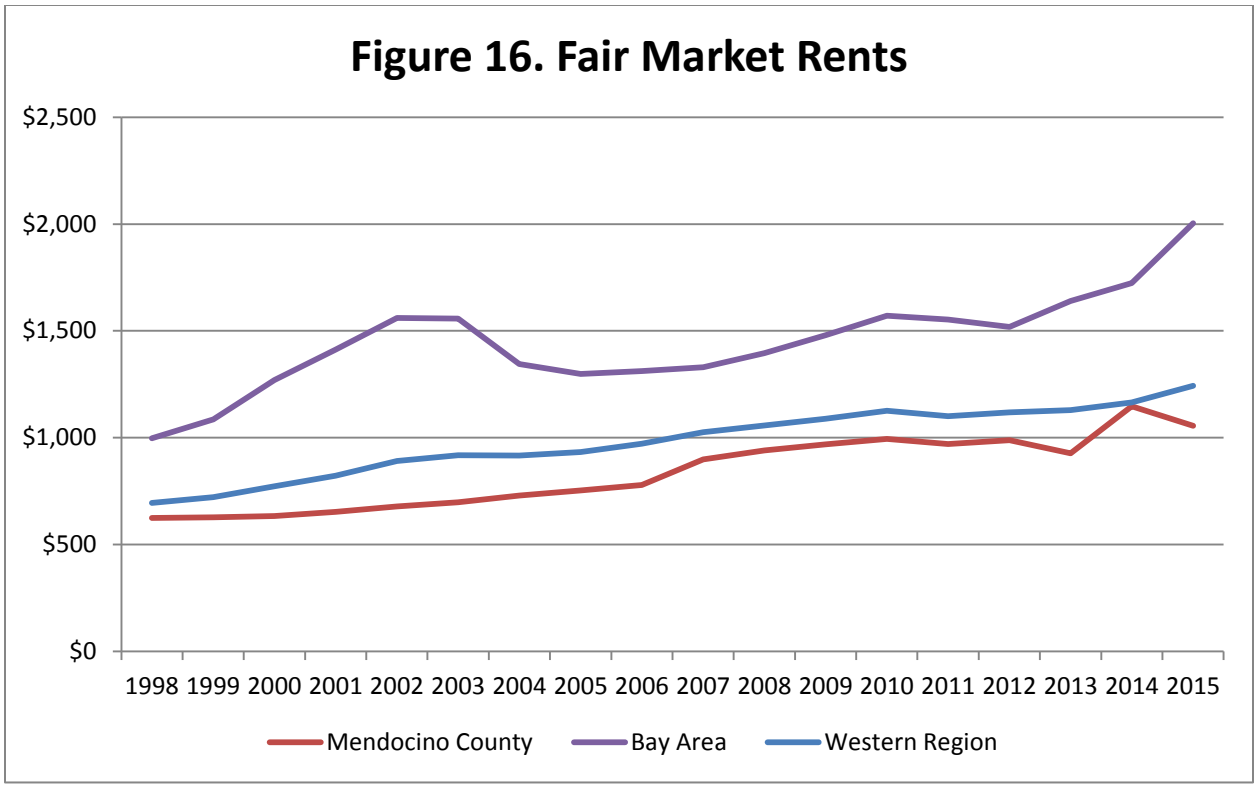
We repeat the ZHVI analysis using the FMR data series. For the sake of brevity, we will merely highlight the results since the methodology is sufficiently covered above. Before moving into the analysis, we will discuss the data and some important differences from the ZHVI data.

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 *Fair Market Rents: Overview*, available at https://www.huduser.gov/portal/datasets/fmr/fmrover_071707R2.doc, clearly outlines the purpose of the FMR data:

> "Fair Market Rents (FMRs) are primarily used to determine payment standard amounts for the Housing Choice Voucher program, to determine initial renewal rents for some expiring project-based Section 8 contracts, to determine initial rents for housing assistance payment (HAP) contracts in the Moderate Rehabilitation Single Room Occupancy program (Mod Rehab), and to serve as a rent ceiling in the HOME rental assistance program. The U.S. Department of Housing and Urban Development (HUD) annually estimates FMRs for 530 metropolitan areas and 2,045 nonmetropolitan county FMR areas. By law the final FMRs for use in any fiscal year must be published and available for use at the start of that fiscal year, on October 1."

The last sentence here presents a need to adjust the FMR data for comparability. The FMR data for a fiscal year is released before the beginning of the Federal fiscal year, which is October 1. That is, the 2017 FMR data is released by HUD before October 1, 2016. The population data used to weight the FMR data is a July 1 estimate and the CPI data are for a calendar year. So, to ensure comparability of the various data series, we set back the FMR data one year, i.e. we re-label the 2016 FMR data as 2015 data as the data represents information from 2015.

Additionally, HUD produces FMR data for differing sizes of housing units, from Efficiency units to 4 Bedroom units. The analysis on the website above focuses on the 2 Bedroom FMR. Since this is the data that is made most readily available by HUD for various geographies in a downloadable format we will also focus our analysis on the 2 Bedroom FMR. Figure 16 shows the FMR figures for Mendocino County, the Bay Area and the Western 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	0.713824
Mendocino – Western Region	0.949054

Figures 17 and 18 show the scatter diagram of Mendocino County FMR compared to the Bay Area (Figure 17) and the Western Region (Figure 18). Figure 19 below shows the values of the correlation coefficient between Mendocino County and the Bay Area and between Mendocino County and the Western Region from 1998 to the reference year.

Figure 17. Comparison of Fair Market Rents

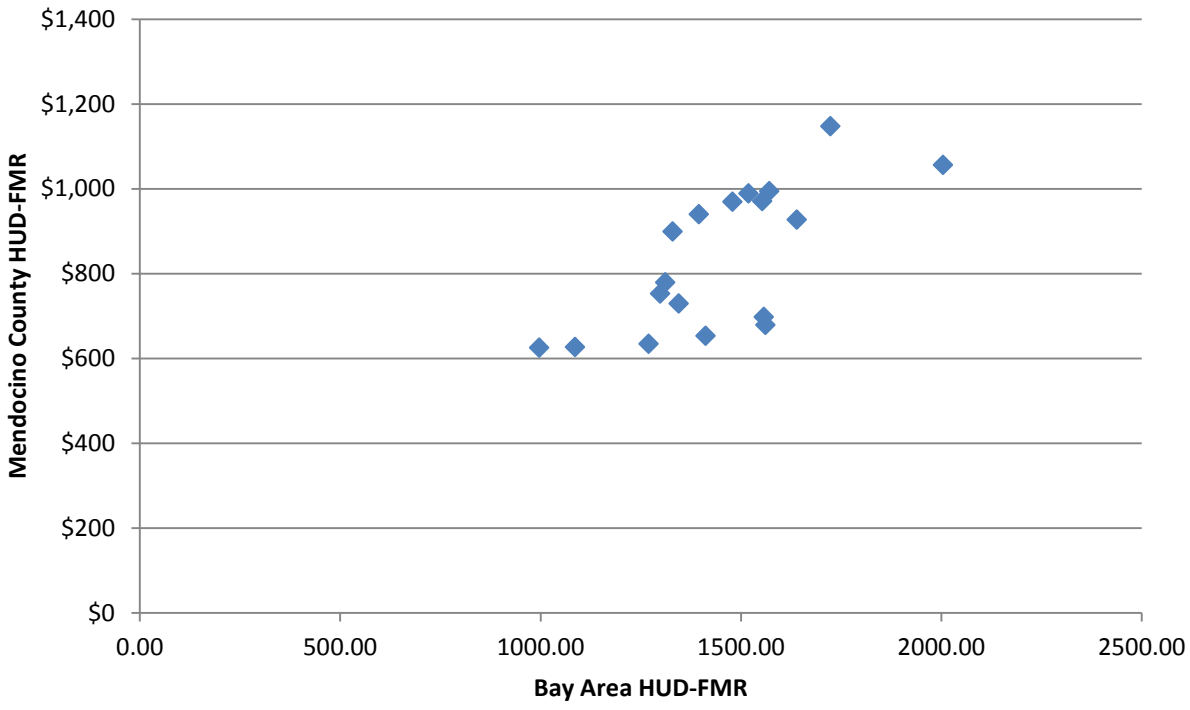
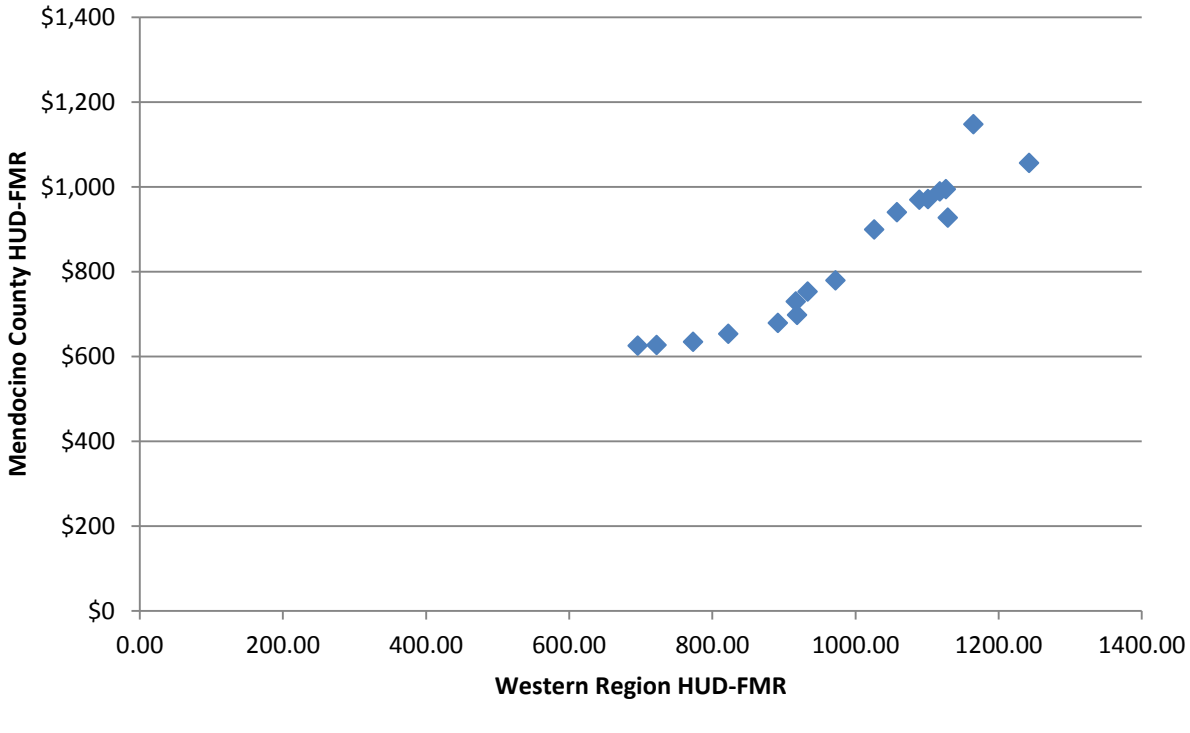
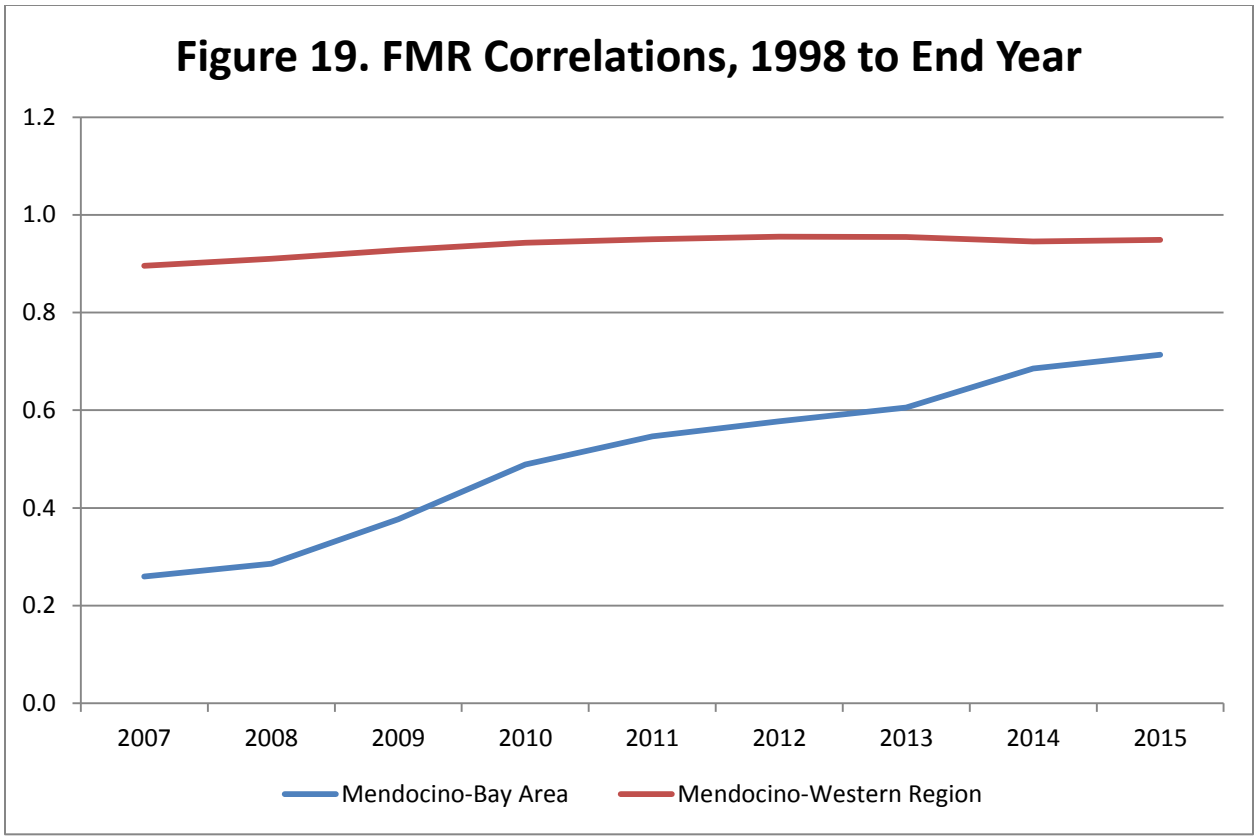


Figure 18. Comparison of Fair Market Rents





Clearly, the Western Region is a better fit for Mendocino County based on the correlation coefficient of the FMR data. We next examine the average annual growth rates.

Table 9. FMR Average Annual Growth Rates by Geography, 1998-2015

Region	Geometric Mean	Log-Linear Regression
Mendocino County	3.13%	3.65%
Bay Area	4.19%	2.44%
Western Region	3.47%	3.09%

In both measures of average annual growth rate, the Western Region is closer to Mendocino County than is the Bay Area. Here we see the significant difference between the growth figures in the Bay Area is a result of multiple negative growth periods. Finally, we examine the regression results.

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

Measure	Bay Area	Western Region
Observations	18	18
R^2	0.9996	0.9999
ANOVA F Value (Significance)	40,170.29 (1.240×10^{-28})	172,751.56 (1.063×10^{-33})
β_1 (Std Error)	0.9237 (0.0046)	0.9758 (0.0023)
β_1 t Stat (p Value)	200.425 (4.022×10^{-30})	415.634 (1.66×10^{-35})

The regression results also show that the Western Region is a better match for Mendocino County than is the Bay Area since the β_1 estimate is closer to the value 1.

Conclusion

This research focuses on a very specific question: which Bureau of Labor Statistics region, the Bay Area or the Western Region, better reflects the rate of inflation in Mendocino County? Since the BLS does not have CPI data for Mendocino County specifically, we were forced to search for alternative means of answering the question.

First, we examined the CPI for the two regions in question. By decomposing the regional indices, we were able to show that differences in housing prices explain more than 100% of the difference between the Bay Area 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 three regions: Mendocino County, Bay Area and Western Region. Population Weighted series were constructed for the Bay Area and Western Region 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 Bay Area ZHVI (FMR) or the Western Region ZHVI (FMR). Those tests were: correlation coefficients, average annual growth rate comparison, and regression analysis. All three tests showed, rather convincingly for both data sets, that Mendocino County is more comparable to the Western Region than it is the Bay Area.

Thus, since we have shown that differences in housing costs serve as an excellent 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, the only logical conclusion is that the Western Region CPI is a better indicator of inflation in Mendocino County than the Bay Area CPI. Accordingly, we offer the following recommendation.

Recommendation:

- Based on the analysis above, we recommend the Mendocino County Employees Retirement Association adopt the Western Region Consumer Price Index for granting Cost of Living Adjustments to retirees in 2017 and subsequent years.