Improving the ACCRA U.S. Regional Cost of Living Index

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The broadest and most commonly used measure of the cost of living across U.S. cities is the American Chamber of Commerce Research Association (ACCRA) index. This index is used by business and government organizations and the media to to rank living standards and real wages across U.S. cities. In this study we reduce the aggregation bias in the index by calculating national average prices for the 59 item prices using population weights instead of the equal weight formula used by ACCRA. This correction results in a decline in the index values for all cities and changes in the rankings and bi-variate comparisons between city pairs. In some high-cost cities the index values decrease by over 25 percent, and in 74 percent of the cities the rank changes by greater than one spot.

Keywords: Cost of Living Index, Population Weighting, Regional Data

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1. Introduction

Regional cost of living indexes are a valuable source of information for individuals who are seeking to move and need to know what income differential is needed to maintain a constant standard of living. Price level differentials are also of interest to economists and other analysts who study issues such as the law of one price and economic linkages across states and countries. The most commonly used measure of cost of living in U.S. cities is produced by the American Chamber of Commerce Research Association (ACCRA). This data measures prices for 59 standardized items in over 300 cities.

Because of this coverage, ACCRA is widely used in the popular press and by economic development offices and similar agencies. *Money* magazine uses it in "Best Places to Live" as an indicator of city costs[2]. PayScale uses it to determine the salary change needed to maintain current lifestyle in a different city[3]. ACCRA is also used by the Missouri Economic Research Center to determine average cost of living in each state[4]. Finally, Statehealthfacts uses ACCRA to examine the lowest, middle and highest costs in a state[5].

Koo, Phillips, and Sigalla [1] pointed out several weaknesses of the ACCRA data and found that one of the most significant weaknesses of the index was aggregation bias caused by the use of an unweighted average of prices across cities to create a national average price. In this paper we show how this bias can easily be corrected using the original price data available from ACCRA and population estimates from the U.S. Census Bureau. Because prices are generally higher in bigger cities, using population weights to derive average national prices results in higher national price indexes and thus

[2]For a list of the rankings see http://money.cnn.com/magazines/moneymag/bplive/2009/

[3] For a description of how ACCRA is most commonly used see http://www.payscale.com/cost-of-living-index.html

[4]For more details see http://www.missourieconomy.org/indicators/cost_of_living/index.stm

[5] For more details see http://www.statehealthfacts.org/comparetable.jsp?cat=1&ind=600

lower values of the price of any city's item price relative to the national average. After adjusting for aggregation bias, the level of the cost of living relative to the national average is shifted down for all cities but not by the same proportion and thus the ranking of cities change and the bivariate comparisons for city pairs also changes. While users of the data can easily correct for this aggregation bias, we encourage the producers of the ACCRA index to adjust their index calculation to improve the usefulness of their index.

2. ACCRA Index Overview

ACCRA is computed from price data collected by volunteers for highly specified items such as the price per pound of T-bone steak, a man's barbershop haircut with no styling and a McDonald's Quarter Pounder with cheese. These items are the same nationwide and so form a national basket of goods used in each city, rather than a changing basket as in the Consumer Price Index (CPI). Items are grouped in six categories: grocery items, housing, utilities, transportation, health care and miscellaneous goods and service. The weights used in creating the index are from the BLS' Consumer Expenditure Survey (CES) for a professional or managerial occupation in the upper quintile of income and there are weights for each item and category[6].

3. Aggregation bias in the ACCRA index

ACCRA computes the index for region r as follows:

$$ACCRA^r = \sum_{i=1}^{N} p_i^{r*}\,\omega_i^* = \sum_{i=1}^{N} \left(\frac{p_i^r}{p_i^*}\right)\omega_i^* \qquad (1)$$

Where p_i^{r*} is the price of item *i* at region *r* relative to that year's sample's national average price of item *i* and ω_i^* is the national consumption weight for item *i*. This weight is the result of multiplying the item weights, w_i, by the category weight, w_c.

An important problem with ACCRA is the aggregation bias created in calculating the national price p_i^* as the simple average of prices across all of the cities surveyed. Thus the national average price

[6] For a complete description of the ACCRA index calculation see http://www.coli.org/.

is relative to what cities pay on average and not what individuals pay on average. ACCRA gives prices in large, populous cities such as New York and Los Angeles the same weight as small cities such as Pueblo, Colorado (population 5,300). Therefore, if higher prices exist in larger population areas, the simple average price will underestimate the price the average person pays. Hence the ACCRA index will overstate the real cost of living in cities because the national price is biased downwards.

As shown in equation 1, the ACCRA index measures the cost of living in a city relative to the national city average. While measured relative to the nation, the ACCRA index is designed as a way to compare cost of living between urban areas. For example, if someone is moving from New York to Dallas, the individual wants to know how income should change to maintain a similar standard of living in the new city. If the primary purpose of the index is comparisons between two cities, then if the national price index cancelled out in the comparison of two cities, the aggregation bias would be unimportant in most uses, although not all. A city that had an index of 190 may have less trouble attracting firms and individuals using a corrected value of say 130 even if all the others cities fall proportionately in value. It is also the case one use of the index is to combine it with other indicators to create a "best place to live" value and then there is no guarantee that the national price index cancels out.

A close look at the prices used and the index formula reveals that the national price indexes in fact do not cancel out and thus the comparison between two cities is also impacted by aggregation bias. The ACCRA index can be written as:

$$ACCRA^r = \sum_{i=1}^{N} p_i^{r*}\,\omega_i^* = \sum_{i=1}^{N}\left(\frac{p_i^r}{p_i^*}\right)\frac{p_i^{*c}q_i^*}{\sum_{i=1}^{N} p_i^* q_i^*} \quad (2)$$

Where $\omega_i^* = \frac{p_i^{*c}q_i^*}{\sum_{i=1}^{N} p_i^* q_i^*}$

expenditures on item *i* = $p_i^{*c}q_i^*$

total expenditures on all items = $\sum_{i=1}^{N} p_i^* q_i^*$

One can see from this equation that a national cost of living index is not calculated separately from the regional cost of living indexes. If it were, and each region were then divided by the national base, then mathematically it would be clear that in city-to-city comparisons the national cost of living would cancel out and the two-city comparison would not be impacted by the aggregation bias in creating the national prices.

However they are not calculated separately, so if p_i^* = p_i^{*C} then,

$$ACCRA^r = \frac{\sum_{i=1}^{N} p_i^r q_i^*}{\sum_{i=1}^{N} p_i^* q_i^*} \quad (3)$$

Then in comparing two cities, say New York and Dallas, the national base cancels and gives:

$$ACCRA^{NY/DL} = \frac{ACCRA^{NY}}{ACCRA^{DL}} = \frac{\sum_{i=1}^{N} p_i^{NY} q_i^*}{\sum_{i=1}^{N} p_i^{DL} q_i^*} \quad (4)$$

As discussed in Koo, Phillips, and Sigalla [1] if p_i^* = p_i^{*C} then the ACCRA index is a Laspeyres-type index with a central-region solution that provides it with the property of transitivity. However, this cancelation does not occur in the ACCRA index because $p_i^* \neq p_i^{*C}$. As described earlier, the price p_i^* is calculated by ACCRA as the average city price (with each city getting an equal weight) and not the average price paid by national consumers, which is how p_i^{*C} is measured. While p_i^* can differ from p_i^{*C} for other reasons, such as a smaller basket of goods used in the ACCRA index compared to the basket used by BLS and the fact p_i^{*C} is taken from the consumer expenditure survey two-years prior, it is likely that the biggest difference between the two stems from the unweighted calculation of p_i^*. Calculating p_i^* with population weights to get it closer to the true national item price, p_i^{*C}, will then get the ACCRA index closer to a Laspeyres-type index and help insure the transitivity of the index.

While the purpose of using population weights to calculate national prices is to reduce aggregation bias, it has the added benefit of reducing the impact of smaller cities dropping in and out of the index. Participation is purely on a voluntary basis, and so the national average is not a random

sample. Michael Raper [2] discusses the possibility of self selection bias in the ACCRA sample. So that areas with lower than average cost of living will be more inclined to participate than those with higher than average values. So that cities dropping out of the index may be ones with higher costs and those entering are ones with lower costs. While ACCRA is not designed and should not be used as a time series, changes in the index value of a city from one quarter to the next can easily be misconstrued as a change in the city's cost of living instead of changes in the national prices caused by selection bias. Using population weights on small cities reduces their impact on the national price and thus the impact of them dropping in and out of the survey. Additionally, the Chambers of Commerce in smaller cities have fewer resources to draw upon and are thus more likely to miss some quarters and without population weighting this will have a great impact on the index. Obviously, however, if large cities drop in and out of the index then the population weighted index will be impacted more than the equal weight index.

4. Results

To reduce the aggregation bias and thus have the calculated national prices reflect the price the average consumer pays, census population data from 2006 was used to weight the first quarter of 2009 price data. Hereafter this new index is called Population ACCRA

This amounts to changing p_i^* in equation 2 from $p_i^* = \sum_{i=1}^{N}(\frac{p_i^r}{N})$ to $p_i^* = \sum_{i=1}^{N} p_i^r \frac{pop_i}{\sum_{i=1}^{N} pop_i^r}$

In this equation pop_i is the population in city i. We first apply this weighting scheme to the individual item prices and then aggregate up to the six broad categories defined by ACCRA. As seen in Table 1, the calculated national average price increased for every category when consumption weights were used to aggregate the national prices for each category. Using consumption weights to aggregate the category prices shows that the national average price increases by close to 20 percent. The increase in national prices caused the index values to fall in each city, and the national average value to fall from 100 to 85.9.

The largest difference in the price for a category occurred in housing. As shown in Table 2, the biggest increase occurred in apartment rent and home price. The price of renting an apartment increased 58.7%, the price of a new home increased 49% and the monthly payment on a mortgage increased 50.9%. Overall, the housing category had a price increase of 52.2%, which caused the housing category average index value to plummet to 65.8, whereas other categories only decreased to between 93.2 and 94.7. Therefore much of the declines in the index values is from changes in average housing related prices after population weighting. This reflects the large variation in housing costs nationwide, and that costs tend to be higher in larger cities and so the cost of living in these large populous cities is sharply overstated by the current ACCRA methodology. This can be seen in Figure 1 where Manhattan and Brooklyn had the largest change in index values between ACCRA and Population ACCRA, both declining over 25%.

Figure 2 shows that the rankings of cities change once population ACCRA is used, because even though all cities' index values decreased, some decreased more so than others. However, cities that originally had very low or very high ranks tended to maintain similar rankings even when using population ACCRA. In fact, the eight most expensive places have the same rank under both indexes. On the other hand, cities ranked in the middle of the ACCRA index (ranks from 100 to 225) changed rank under population ACCRA more so than cities ranked towards the ends under ACCRA. As can be seen in Table 3, Laramie, Wyoming came off the best by becoming 29 places cheaper, whereas Lima, Ohio came off the worst as it became 34 places more expensive. In total, 113 places became more expensive, 80 did not change rank or only moved one spot, and 116 places became cheaper.

5. Impacts on other measures

It is interesting to look at the impact of our changes on measures created by other institutions that use the ACCRA index in their calculations. A group that uses the ACCRA index that is particularly

impacted by the aggregation bias is the Missouri Economic Research Center. They create and publish a state level cost of living index by simply averaging the index values for all regions in the state.

Because of the aggregation bias in the ACCRA data, the state level averages are all overstated. We calculated the results again with the population ACCRA, and the state averages all decreased. While 45 states' ranks did not change or changed only one place, Georgia became more expensive by 3 places, Texas became cheaper by 3 places and Wyoming became cheaper by 6 places. This would seem to suggest that, while population weighting the individual cities does not have a uniform impact, it does maintain the relationships between most states, as seen in Figure 3.

However using a simple average of the cities available in a state would also suffer from aggregation bias since the index for states with more small cities reporting would be biased downward. We thus create a population weighted average of all the cities in each state, rather than the unweighted average which gives equal weight to Manhattan and Glen Falls in the state average of New York. As seen in Figure 4, even using ACCRA data to create a weighted state average drastically changes the rankings across states compared to the unweighted average. However, the difference of rank between a weighted and unweighted average is smaller for population ACCRA than ACCRA. This can be seen in Table 4, where the standard deviation for the difference in ranks between the weighted and unweighted state averages is smaller for population ACCRA than ACCRA.

6. Conclusions

The ACCRA cost of living index is a key source of information on the cost of living across U.S. cities. It appeals to many users because it covers over 300 cities and it publishes prices on 59 standardized products in six broad categories of spending. In this article we correct for aggregation bias in the index which is caused by the method used by ACCRA to create national base prices for each of the price items in the index.

In computing the national average prices, ACCRA is currently measuring the average city price, rather than the price the average consumer is paying. We show that correcting for this bias has significant impacts on the level of the index for cities and well as city ranks and city pair comparisons.

Acknowledgements

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References

[1] J. Koo, K. Phillips, and F.D. Sigalla, Measuring Regional Cost of Living, *Journal of Business & Economic Statistics* 18 (2000), 127-135.

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Table 1
Category Results after Population Weighting

CATEGORY	% Price Difference Weighted by Consumption Weights	New ACCRA Avg.
Groceries	6.4	94.1
Housing	52.2	65.8
Utilities	7.5	93.2
Transportation	5.4	94.9
Health Care	5.8	94.7
Misc.	6.7	94.1
Composite	19.8	85.9

Table 2
Price Differentials for Selected Items

Selected Items (Housing and Utilities categories only)	Unweighted National Price	Population Weighted National Price	% Change
Apartment Rent	$812.14	$1,289.21	58.7%
Home Price	$303,713.32	$452,482.52	49.0%
Mortgage Rate (%)	5.08%	5.16%	1.6%
Home Payment (principle + interest)	$1,236.02	$1,865.65	50.9%
All Electric house	$173.83	$176.46	1.5%
Part Electric	$94.38	$113.49	20.3%
Other Energy	$97.67	$98.70	1.1%
Total Energy	$188.45	$208.20	10.5%
Phone	$26.74	$27.32	2.2%

Table 3
City Results after Population Weighting

Selected Cities	ACCRA	Population ACCRA	ACCRA Rank	Population ACCRA Rank	Difference in Rank	% Change in Index
Manhattan, NY	219.3	172.25	309	309	0	-27.30%
Los Angeles, CA	142.2	114.14	299	298	1	-24.55%
Chicago, IL	113.5	95.47	263	263	0	-18.86%
San Antonio, TX	93.6	80.19	130	106	24	-16.68%
Dallas, TX	92.9	81.17	115	136	-21	-14.41%
Pueblo, CO	83.7	73.26	2	2	0	-14.20%
Laramie, WY	97	82.35	182	153	29	-17.85%
Lima, OH	94.0	83.18	139	173	-34	-13.00%

Table 4
Difference Between Average[7] State Ranks in:

Difference	ACCRA vs. Pop ACCRA	ACCRA vs. ACCRA weighted	Pop ACCRA vs. Pop ACCRA weighted	ACCRA weighted vs. Pop ACCRA weighted	ACCRA vs. Pop ACCRA weighted
0-2	48	31	34	48	33
3-5	2	11	5	3	6
5-10	1	7	9	0	9
>10	0	2	0	0	3
Standard Deviation	0.890	4.104	3.811	1.2	4.359

[7] Averages are unweighted unless otherwise listed as weighted

Figure 1
City Comparisons of Index Values, Before and After Population Weighting

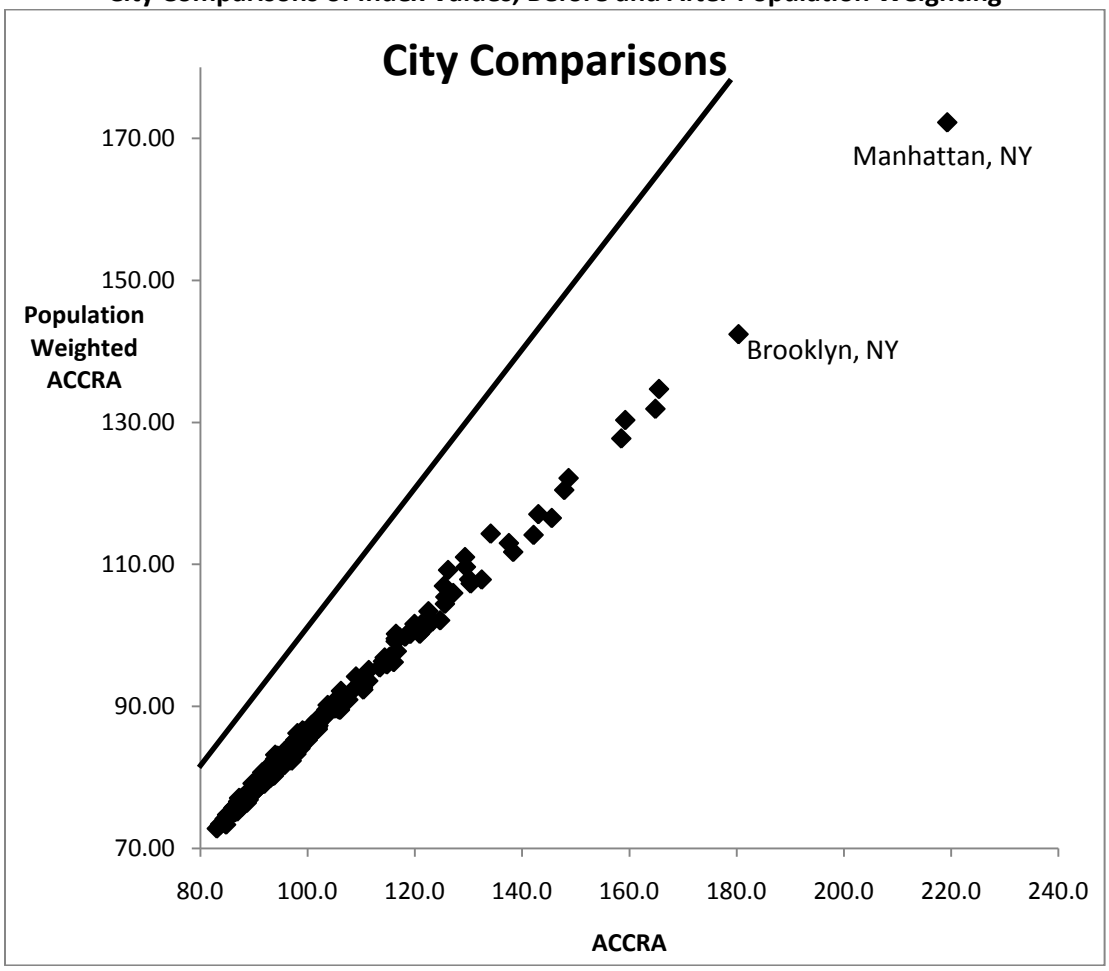

Figure 2
City Comparisons of Ranking, Before and After Population Weighting

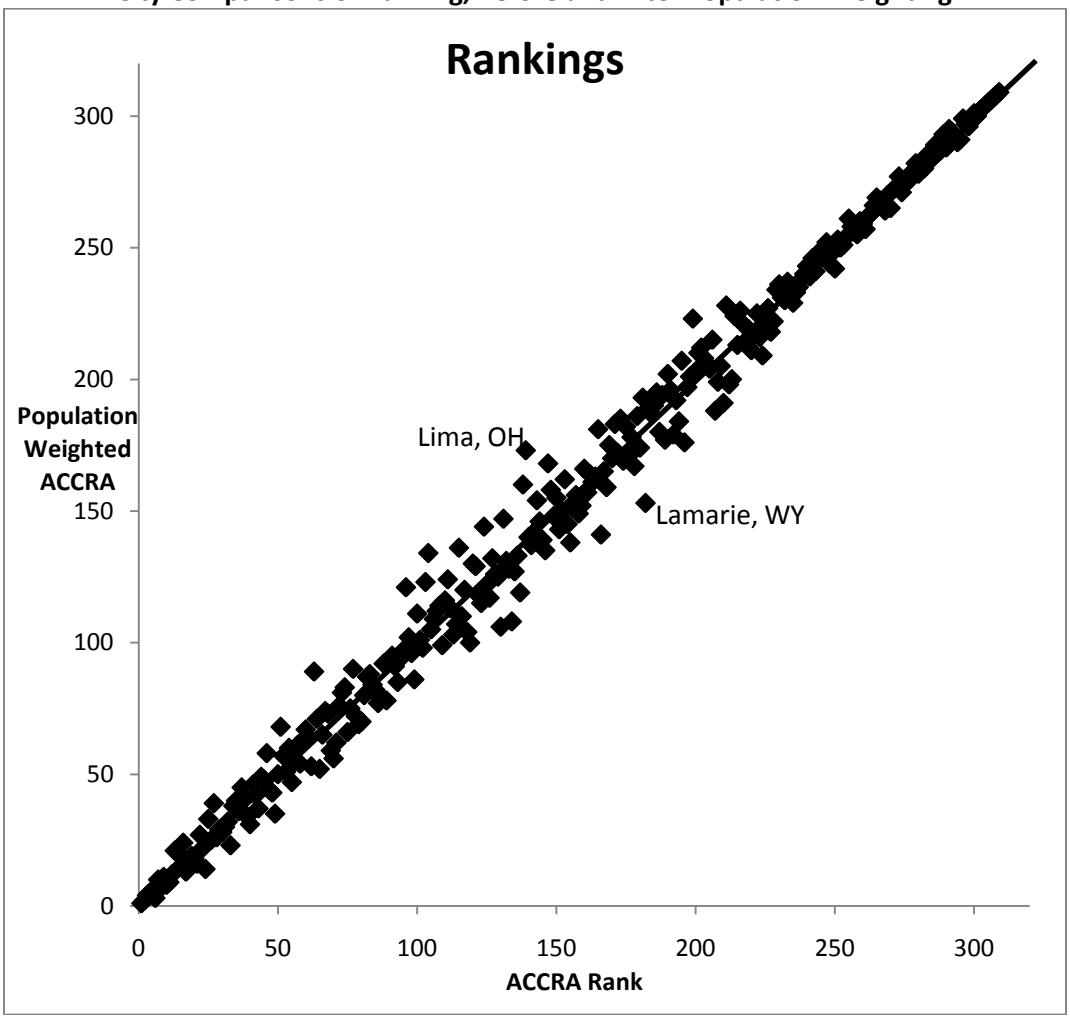

Figure 3
State Average Rank Comparison

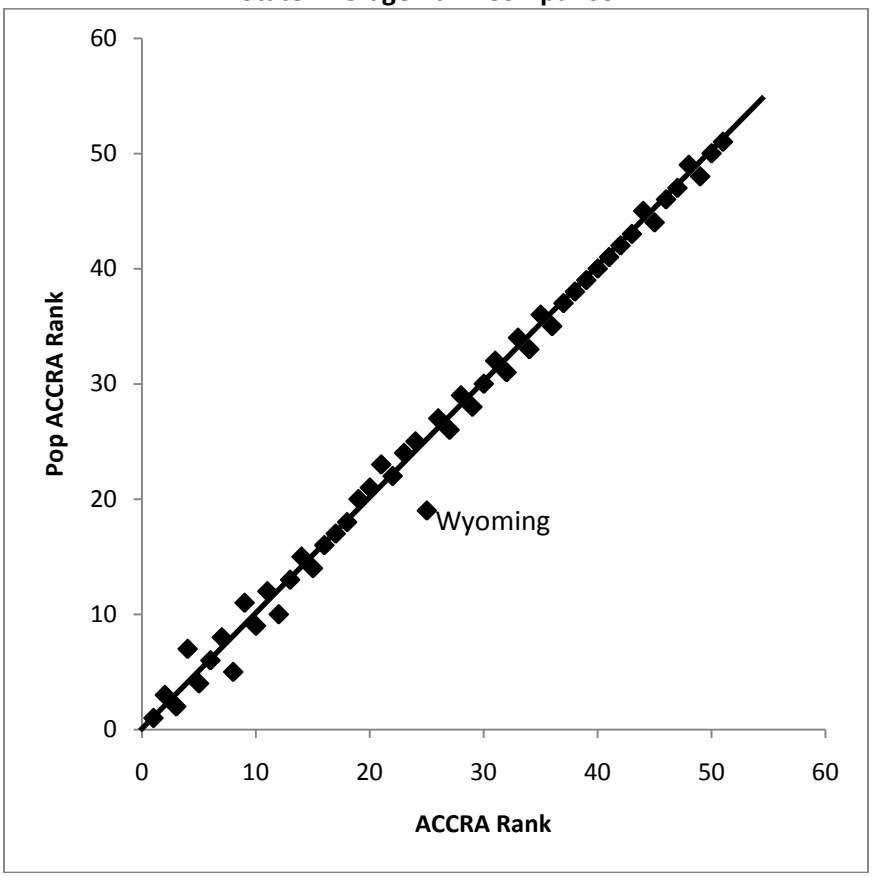

Figure 4
ACCRA State Weighted Average Rank Comparison