

**IN THIS ISSUE****Assessing the Relationship between  
Income and Usage Levels****NOTE TO READERS****ON-LINE DELIVERY**

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**CHALLENGES EXIST IN USING CENSUS  
DATA ON MEDIAN INCOME TO ASSESS THE  
RELATIONSHIP BETWEEN LOW-INCOME  
STATUS AND NATURAL GAS USAGE LEVELS**

Many utilities today are seeking major redesigns of their residential rate structures. One common proposal is to substantially increase the monthly fixed customer charge. Whether simply reallocating additional costs to the customer charge, or moving to a "straight fixed-variable" (SFV) rate design, these utilities often propose fixed charges in the range of \$25 to \$35 per month.

Proponents of these increases in the fixed monthly charges have argued that the increase in fixed charges benefits low-income customers. Unquestionably, a move to a higher fixed monthly charge benefits high use customers relative to low-use customers.

A proposal to substantially increase fixed monthly charges thus directly presents the issue of how to characterize low-income customers. If income and consumption are directly associated, with usage increasing as income increases, the move to high monthly fixed charges harms the poor. If, however, low-income customers are disproportionately high use, the move to higher fixed monthly customer charges will benefit the poor.

However that question is answered, Fisher Sheehan and Colton (FSC) recently had occasion to identify weaknesses in one utility's efforts to empirically demonstrate that low-income customers tend to have higher than average consumption. FSC responded that while low-income customers may have less efficient consumption (higher use on a per-square-foot of housing basis), they have sufficiently smaller

housing that *overall* consumption is lower than the residential average.

### THE COLUMBIA GAS ANALYSIS

In its 2011 rate case in Pennsylvania, Columbia Gas argued that low-income customers use more natural gas than do residential customers on average. The company compared consumption in “low-income” zip codes to consumption in non-low-income zip codes. It defined a low-income zip code by ranking all zip codes in its service territory by median income; the zip codes with the lowest median incomes were deemed to be low-income.

In calling the Columbia Gas analysis “fundamentally flawed,” FSC presented an analysis showing the weaknesses in the Columbia Gas analysis. In rejecting the Columbia Gas proposal to substantially increase its fixed monthly customer charge, the Pennsylvania PUC cited these weaknesses.

### LOWER MEDIAN INCOME DOES NOT EQUAL “LOW-INCOME”

The first problem presented by the Columbia Gas analysis, FSC said, was that “it does not measure what it purports to measure.” The company analysis used 2000 Census data to determine median income for zip codes in the Columbia Gas service territory. It then sought to determine what relationship, if any, existed between the natural gas consumption within those zip codes and the median income within those zip codes. The problem, FSC said, is that the level of median income for any given zip code has little or no relationship to the prevalence or to the depth of poverty (or low-income status) within that zip code.

Using the zip codes identified by Columbia Gas as representing its service territory, and excluding those zip codes that did not exist in the year 2000, FSC examined the median income for each zip code as that median income related to the Federal Poverty Level for 2000. That comparison showed that median income provides no

meaningful information about the prevalence of low-income households or what the incomes of those low-income households might be.

Consider that in 2000, 100% of the Federal Poverty Level was \$11,250 for a 2-person household, and was \$14,150 for a 3-person household. FSC found that assuming an average household size of 2-persons, the median income in the zip codes studied by the company would have not been at or below 165% of Federal Poverty Level in any zip code. In contrast, the median incomes used by Columbia Gas in its analysis would have been:

- Between 200% and 300% of Poverty Level in 110 instances;
- Between 300% and 400% of Poverty Level in 100 instances;
- Between 400% and 500% of Poverty Level in 29 instances;
- More than 500% of Poverty Level in 15 instances.

Alternatively, assuming an average household size of three persons, the median income in the zip codes studied by the company would have fallen below 150% of Poverty Level in only three cases. In contrast, the median income would have fallen:

- Between 200% and 300% of Poverty Level in 150 instances;
- Between 300% and 400% of Poverty Level in 50 instances; and
- More than 400% of Poverty Level in 15 instances.

Drawing conclusions about the consumption patterns of low-income customers, FSC said, is inappropriate when the data used does not involve low-income customers.

## **MEDIAN INCOME AND THE DEPTH OF POVERTY**

While Columbia Gas used median income as the point of reference for its analysis, that income data provided no information on the depth of Poverty.

The “median” income tells us, FSC said, at what point 50% of all households have income greater than the median and 50% of all households have income lower than the median. It does *not* tell us, however, anything about the distribution of incomes above and below the median.

Three zip codes could have identical median incomes, for example, and yet have substantially different income characteristics. Zip Code 1 might have households grouped tightly around the median. Zip Code 2 might have many of its households in the “bottom” half, truly poor. Zip Code 3 might have few households in the “top” half near the median and many households in the upper income tiers above the median.

A review of the zip codes comprising the company’s service territory in 2000 reveals that just as those zip codes do not have an even distribution of income for households with annual income either below \$10,000 or below \$20,000, neither do those zip codes have an even distribution of income for households with annual income either above \$75,000 or above \$100,000 a year. Knowing the median income provides no information about either the presence or the depth of low-income status in any given zip code. A zip code with a somewhat lower median might still have higher consumption because of the distribution of income either above or below the median (or both).

Moreover, a lower median income in a zip code does not necessarily indicate the presence of a lower income population in that zip code. In addition to looking at the spread of income both above and below the median in each zip code, FSC examined the relationship between the level of median income and the percentage of low-income households, measured both by dollars of

income and by the ratio of income to Federal Poverty Level.

There is virtually no explanatory power provided by the level of median income. The statistical “fit” between median income and the percentage of households below 50% of Poverty Level is virtually non-existent. So, too, is the fit between median income and the percentage of households below 100% of Federal Poverty Level virtually non-existent. The fit between the median income by zip code and the percentage of households with income below \$10,000 or \$20,000 is somewhat higher, but still very poor, indicating little or no relationship. FSC concluded that median income cannot be used as a surrogate for low-income status as indicated by Columbia Gas.

## **MEDIAN INCOME AND THE MIX OF POVERTY**

Another way exists to empirically examine whether one can use median income as a surrogate for low-income status. The “median income” measure reported by the Census is based on traditional notions of what constitutes the “median.” To report a “median household income” is to report an income where one-half the households have income greater than the median and one-half the households have income less than the median.

The median income does not indicate anything about the *mix* of households above and below the median. In a hypothetical five household population, for example, a population with incomes of \$2,000; \$5,000; \$25,000; \$26,000; and \$27,000; would have the same median income (\$25,000) as a population with incomes of \$24,999; \$24,999; \$25,000; \$150,000; and \$210,000. To observe that the median income in both of these hypothetical examples is \$25,000 would not accurately portray the income characteristics of the geographic area.

To test the significance of this observation for an area such as the Columbia Gas service territory in Pennsylvania, FSC examined the zip codes that make up the Columbia Gas service territory

(as identified by Columbia Gas). FSC then ranked those zip codes by median income and assigned each zip code to a decile. The “first decile” involves the ten percent lowest income zip codes, while the “tenth decile” involves the ten percent highest income zip codes. That analysis revealed:

First, that the zip codes with the lowest median incomes contained a considerable number of “high income” households. In seven of the 26 zip codes in the lowest decile range of median income, more than 10% of households lived with annual incomes of more than \$75,000 (in 2000). In the second lowest decile, six of the 26 zip codes have more than 10% of their households with annual incomes of \$75,000 or more.

Second, that in the zip codes with the highest median income, 19 of the 26 zip codes had more than 10% of their households with annual incomes at or below \$20,000; in the next highest decile, 16 of the 26 zip codes had more than 15% of their households with annual incomes at or below \$20,000.

#### **MEDIAN INCOME AND AGGREGATE INCOME**

An alternative way exists to determine whether there is a relationship between median income and the overall income status of a zip code. FSC examined the aggregate income within each zip code holding the median income and the population size for each zip code constant. If a lower median income, in fact, indicates a lower income status for the zip code, within each Population Group, the aggregate income should increase as the median income increases. Within all zip codes with a population of 2,500 to 5,000 persons, for example, a zip code with a lower median income should also have a lower aggregate income than a zip code with a higher median income. In the Columbia Gas service territory, that does not occur.

The data developed by FSC found that the level of aggregate income in a zip code does not typi-

cally flow from the level of median income in that zip code (holding population constant). In no Population Group<sup>1</sup> did the lowest aggregate income appear in zip codes with the lowest median income; in only one Population Group was the lowest aggregate income in zip codes with the second lowest median income. In Population Group 1, the highest aggregate income fell in the zip codes with the lowest median, while the lowest aggregate fell in the zip codes with the second highest median income, exactly the opposite of what one would expect if the Columbia Gas analysis was valid. In Population Group 3, the highest aggregate income fell in Decile 5 (right in the middle of the level of median incomes), while the lowest aggregate fell in Decile 4 (again, in the middle of median incomes).

The clear conclusion is that, contrary to the company’s assertion that a lower median income in a zip code can be used to categorize the income status of the zip code, no conclusions can be drawn about the income status of a zip code based only on the median income of that zip code.

#### **MEDIAN INCOME CHANGES OVER TIME**

One problem with seeking to associate natural gas consumption with median income involves the mismatch of data in time. Consider, for example, that Columbia Gas associated consumption for customers that were “active” on the Columbia Gas system on December 31, 2000 with 2000 Census data. Data for the “2000 Census,” however, involves 1999 data. There is a considerable lag between the time at which Columbia Gas determines its consumption and the time the Census determines the income for that same geographic area. In the meantime, particularly at a geographic level as small as a five-digit zip code, the level of median income is highly variable.

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<sup>1</sup> Each Population Group represented a range of persons per zip code. The zip codes were divided into nine different “Population Groups” based on the number of persons.

Data for a geographic area as small as a “zip code” is not available on a regular annual basis. The sample sizes used by the Census Bureau for its between-Census “American Community Survey” simply does not allow for reporting results at a zip code level. However, data from the annual American Community Survey is reported for a geographic area known as the Public Use Microdata Area (PUMA). FSC selected three-year PUMA data for Pennsylvania for 2009, 2008 and 2007.<sup>2</sup> To this extent, the variability one would expect to find in income data for small geographic areas is smoothed somewhat. Year-to-year data (using single year data) would be even more variable than what this three-year data will show.

Pennsylvania is divided into 93 PUMAs (Public Use Microdata Areas). In defining the geographic area of a “PUMA,” the Census Bureau seeks to recognize existing geopolitical boundaries. Accordingly, for example, rarely do PUMAs cross county boundaries.

For each of three study years (2007, 2008 and 2009),<sup>3</sup> FSC ranked each Pennsylvania PUMA by mean (not median) income. The American Community Survey does not report median income by PUMA. The ranking of “1” represented the PUMA with the lowest mean income, and the ranking of “93” represented the PUMA with the highest mean income. FSC, in turn, divided the rankings into deciles. The ten PUMAs with the lowest mean income were in Decile 1, while the ten PUMAs with the highest mean income were in Decile 10. FSC performed this ranking for each of the three study years and compared the results.

Relative average income at the PUMA level remained constant in only roughly half of the cases. FSC compared 2007 against 2008, 2008

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<sup>2</sup> When references are made to “three-year data,” the “2009” data represents a three year average for 2007 – 2009. The “2008” data represents a three year average for 2006 – 2008. The “2007” data represents a three year average for 2005 – 2007.

<sup>3</sup> Remember, each study year is, in turn, based on three years of data.

against 2009, and 2007 against 2009. A PUMA, which will have a more constant relative income than a zip code, since it is a significantly bigger geographic area than a zip code, remained in the same income decile in exactly half of the instances for the two one-year comparisons, and in somewhat fewer than half the instances in the two-year comparison. Roughly ten percent (10%) of the PUMAs had income variability sufficiently large that they changed their relative income position by two or more deciles (not merely two or more rankings).

In fact, FSC concluded that Columbia Gas could not even say that it was making the correct characterization of income when it set forth its analysis. There is a two year lag between the receipt of household income relied upon and the consumption of natural gas that the company relied upon. In that two year period, the relative income of the geographic areas would not only *possibly* have changed but would likely have changed. There are as many “lower-income” geographic areas (PUMAs) that are becoming relatively more wealthy as there are “higher-income” geographic areas that are becoming relatively less wealthy.

The timing mismatch between the income data used by Columbia Gas and the consumption data used makes it impossible to draw the conclusions that the company purports to draw from its data.

#### **MEDIAN INCOME AND PRIMARY HEATING FUELS**

Columbia Gas bases its analysis of the relationship between income and natural gas consumption on a comparison of the income of the users of all fuels with the consumption of natural gas customers. That analysis depends for its legitimacy on the assumption that the median income for all households in a zip code accurately represents the median income of all natural gas customers in that same zip code. Columbia Gas, for example, might match natural gas consumption in a zip code with a median income of \$30,000 (a lower than average median income) and find

that gas consumption is higher than average. The company thus draws the conclusion from this match that lower income households have higher than average natural gas consumption. If, however, the median income for *natural gas* customers in that zip code is significantly higher, and the low overall median income is due to lower-income households using electricity as their primary heating fuel, the company's conclusion is in error. Matching gas usage to median income for all households provides no useful information unless the income of gas customers and the income of all households reflect each other.

In Pennsylvania, the two primary alternatives to using natural gas as the primary heating fuel involve the use of electricity and the use of fuel oil. Due to the small sample sizes involved with providing Census micro-use data, however, the Census does not release micro-data at the zip code level. It is, however, possible to obtain PUMA data for the 2000 Census. FSC, therefore, obtained data on all 93 PUMAs for the state of Pennsylvania. Since the Census does not provide median incomes, FSC relied on mean incomes as the measurement of the point of central tendency.

While there are instances where the income of natural gas customers is lower than the income of customers of alternative fuels, that is by far the exception rather than the rule. Out of Pennsylvania's 93 PUMAs, the income of natural gas customers exceeds the income of electric customers by 15% or more in 52 instances. Further, the income of natural gas customers exceeds the income of electric customers by 25% or more in 22 of Pennsylvania's 93 PUMAs.

The same is true for fuel oil, albeit to a lesser degree. Out of Pennsylvania's 93 PUMAs, the income of natural gas customers exceeded the income of fuel oil customers by 15% or more in 30 instances. It exceeded the income of fuel oil customers by 25% or more in eleven (11) instances.

When Columbia Gas states that higher than average natural gas consumption is associated with a lower than average income for the zip code, that statement has no real meaning. We know, FSC said, that the income of natural gas users is higher than the income of users of alternative fuels. The company's analysis provides no basis from which to draw conclusions with respect to the level of natural gas use and the income of natural gas users.

### SUMMARY AND CONCLUSIONS

One cannot draw any conclusions about the relationship between low-income status and natural gas consumption from the "study" presented by Columbia Gas. Even if accurate with which to begin, the company's data does not present low-income data. The median incomes that the company uses are well above the Federal Poverty Level, generally reaching well above 300% and 400% of Poverty Level and sometimes reaching more than 500% of Poverty Level. In *no* instance does the median income fall at or near the Federal Poverty Level.

Moreover, the use of median income does not provide information on the depth of poverty or on the incidence of poverty within a zip code. Zip codes with higher median incomes have considerable populations with very low annual incomes, while zip codes with lower median incomes have considerable populations with very high annual incomes.

Finally, the timing mismatch between when income data was generated and when consumption data was generated reveals that the median income of the geographic area not only "may" have changed, but is most likely to have changed.

For a complete copy of the FSC analysis of the use of Census data on median incomes in Pennsylvania to assess the relationship between income and natural gas consumption, please write:

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Fisher, Sheehan and Colton, Public Finance and General Economics (FSC) provides economic, financial and regulatory consulting. The areas in which *FSC* has worked include energy law and economics, fair housing, affordable housing development, local planning and zoning, energy efficiency planning, community economic development, poverty and telecommunications policy, regulatory economics, and public welfare policy.