**Income Inequality Over Time: How Choice of a Metric Matters**

Brian Glassman

Poverty Statistics Branch

Social, Economic, and Housing Statistics Division

U.S. Census Bureau

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**Abstract**

 Many previous studies have found that income inequality has increased over the last half century in the United States. However, I examine this issue differently than studies have previously. First, I use the 2005 to 2015 American Community Surveys (ACS) to calculate equivalence and cost of living adjusted household income. While the ACS has been used to measure income inequality, it is less often used to measure changes in income inequality over time. Second, I look at how changes in income inequality vary by income inequality metric. I use nine income inequality metrics along with income share quintiles. Third, I look at how changes in income inequality vary by type of household income. I separate pre-tax, pre-transfer household income and after-tax, after-transfer household income. Fourth, I look at how income inequality changes vary by year. Rather than just talk about the overall increase in income inequality, I look at how year to year changes in income inequality may be positive, negative, or not statistically significant. Finally, I look at how income inequality changes by Metropolitan Statistical Area (MSA). While the trend in the United States is for income inequality to be increasing, this trend is not universal across MSAs.

*Disclaimer:*

*This paper is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed on statistical, methodological, technical, or operational issues are those of the author and not necessarily of the U.S. Census Bureau.*

**Introduction**

 In this paper, I use one-year estimates from the 2005 American Community Survey through the 2015 American Community Survey to explore how household income inequality has changed over time. The American Community Survey (ACS) was designed as a replacement for the Census long form. It is an ongoing survey of around 3 million addresses and it provides data on demographic, social, economic, and housing characteristics. It includes income questions about wages and salaries, self-employment income, interest and dividend, Social Security, Supplemental Security Income, public assistance, and retirement.

There are some advantages and disadvantages to using the ACS compared to other possible sources. One advantage is sample sizes are significantly larger than the Current Population Survey, which allows one to look at smaller levels of geography. Another advantage is that it includes questions about cash transfers, which may not be available in IRS tax data. Furthermore, the ACS has income data for tax filers and non-filers alike, while IRS data lacks information about non-filers. The main disadvantage is the short coverage period. The ACS has only been around since 2005 so the time horizon in this paper is only 11 years: from 2005 to 2015. Another disadvantage is the ACS has no information on capital gains. This may serve to under-estimate the true amount of income inequality.

The ACS is used as the data source for this paper for two main reasons. First, its large size allows for the examination of income inequality in a disaggregated way, namely by Metropolitan Statistical Area (MSA). The smaller size of other surveys do not allow for this type of analysis. This is important because, while changes in income inequality over time for the United States have been well documented, what income inequality looks like in MSAs and how it has changed over time has not.

 Second, the ACS is a dataset that has rarely been used to examine how income inequality has changed over time. Since it is relatively new and only allows for research back to 2005, it has largely been ignored when researchers have looked at similar questions. However, there is now over a decade of data and it now makes sense to use the ACS to look at changes over time.

Other than the use of the ACS, the other thing I do in this paper, which has generally not been done in previous research, is use multiple different income inequality metrics to answer my research questions. The income inequality metrics used in the analysis of this paper are broken into four general categories. The first category are summary measures. These include the Gini Index and the generalized entropy measures.

The Gini sums up the absolute differences between each pair-wise comparison of household income. This gives a statistical measure of income inequality ranging from zero, perfect equality, to one, perfect inequality. While the Gini offers ease of interpretation and the ability to easily compare among different geographical areas, it does have some limitations. First, while the Gini Index can show that income inequality exists, it does not give any information about where in the income distribution the inequality exists. Second, the Gini Index is over-sensitive to changes in household income towards the middle of the distribution and not sensitive enough to changes in household income at the lower and upper portions of the income distribution (Glassman (2016), Krozer (2015), Hasenheit (2014)). This means that the Gini Index could be unchanged or even show less inequality while societal income is becoming more polarized.

The generalized entropy measures are the Theil Index and the Mean Logarithmic Deviation of Income (MLD). Both of these measures, like the Gini Index, are summary measures of income dispersion. However, the Theil Index is more sensitive to changes that affect the upper part of the income distribution, while the MLD is more sensitive to changes that affect the lower part of the income distribution (Glassman (2016), World Bank Institute 2005). Furthermore, unlike the Gini Index, neither of these measures is bounded from above. The main limitation for these measures is that they are both calculated using the natural log which means they are undefined for income less than or equal to zero.

The second category of income inequality metrics are income ratios. The first of these metrics is the Palma Ratio. This measure is calculated by dividing the total income accrued by households in the top 10 percent of the income distribution by the total income accrued by households in the bottom 40 percent of the income distribution. The next metric is called the 80:20 ratio. This ratio compares how much richer the top 20 percent of households are compared to the bottom 20 percent of households. This metric is calculated by dividing the income at the top quintile cutoff point by the income at the bottom quintile cutoff point. This ratio ignores the effect of the middle 60 percent, which tends to be stable and less interesting economically**.**

 The third category of metrics look at non-overlapping parts of the income distribution and are calculated using the same methods as the 80:20 ratio. These metrics are the 90:10 ratio and the 99:90 ratio. The 90:10 ratio is then further broken down into the 90:50 ratio and the 50:10 ratio. Each of these ratios show what is happening at different parts of the income distribution and thus provide a more complete view of income inequality then a simple summary measure.

The fourth category of metrics are income shares. The first type of income shares are by quintiles. These represent the share of income accrued by the bottom twenty percent of the income distribution up to the top twenty percent of the income distribution. These five measures taken together give a comprehensive picture of the household income distribution. The second type is the income share held by the top one percent of the income distribution.

The purpose of this paper is to identify trends in household income inequality from 2005 to 2015. To do this, I address several related questions. First, how has the effect of government programs, defined in this paper as cash transfer payments and federal and state taxes, on income inequality changed over time? I also look at how these effects vary by income inequality metric.

Second, how do the changes in income inequality over this time period vary based on the income inequality metric used? I answer this question in three different ways:

1. Compare income inequality metrics in 2005 to income inequality metrics in 2015.
2. Examine how income inequality metrics change year-by-year from 2005 to 2015
3. Examine how income inequality metrics change from 2005 to 2015 in MSAs

**Literature Review**

The research on how income inequality has changed over time has mainly used two sources of data. The first is IRS tax data. This is used most famously by Piketty and Saez in their 2003 paper and in regular updates over the last 13 years (Piketty and Saez 2003). This is a great source of historical data on tax filers, which these authors use from 1913 to the present to examine how pre-tax income inequality, measured by income shares among and within the top decile, has changed over time. The authors find evidence of increasing income inequality from about the late-1970s through the present.

The second source is the Current Population Survey (CPS). Income inequality can be measured from 1967 to the present for households using a large amount of information on income (Gindelsky (2015); Meyer and Sullivan (2013); Burkhauser (2011); McNichol et al. (2012); Heathcote, Perri, and Violante (2009); Gottschalk and Danziger (2005)). A combination of the two sources has been used as well. The Congressional Budget Office (CBO) used the Statistics of Income (SOI), which is a nationaly representative sample of tax returns collected by the IRS, matched with the CPS to examine how income inequality changed over three decades (CBO 2011). The CBO report examined how income inequality changed from 1979 to 2007. The analysis also looked at the effect of government programs. In other words, how does income inequality differ based on pre-tax, pre-transfer income versus after-tax, after-transfer income?

 Though these two sources are the most often used, other data sources have been used to measure income inequality. The Bureau of Labor Statistics produced an article in September of 2015 in which they used the Occupational Employment Statistics (OES) to measure wage inequality, using the 90-10 Ratio, in MSAs from 2003 to 2013 (Cunningham (2015)). The author finds an increase in wage inequality overall for the U.S., but the increase was not uniform as he shows that more populous MSAs had larger increases in income inequality over time than less-populous MSAs.

A 2011 Census Bureau report used American Community Survey five-year estimates to look at income inequality, measured by the Gini Index, the 90-10 ratio, and the 95-20 Ratio, nationally, in states, and in Metropolitan Statistical Areas (MSAs) with over one million people (Weinberg 2011). This report covered the 2005-2009 time period, but produced single estimates for the time period. Mather and Jarosz (2014) used Decennial Census data for 1990 and 2000 and ACS five-year estimates for 2008-2012 to look at income inequality and poverty in counties. The focus of their report was on how income inequality, measured by the Gini Index, was related to poverty in counties and how this relationship changed over time from 1989 to 2012. A report released in 2016 by the Brookings Institution (Holmes and Berube (2016)) used ACS data to look at how pre-tax income inequality, measured by the 95-20 ratio, changed from 2007 to 2014 in the 100 largest MSAs and the cities within those MSAs.

In the table below, some of the recent literature on income inequality over time is summarized in order to quickly compare what has been done in previous literature with what was done in this paper. A few differences between previous work and this paper are displayed in the table. First, this paper uses a dataset that is not often used for this type of work for a time period which is recent enough to not have been studied well. Second, this paper uses income after transfers are added in and after federal and state taxes are taken into account. While several papers have taken federal taxes into account, only one other paper to my knowledge has also taken state taxes into account. Third, most previous work has examined income inequality at the national level. Fourth, this paper examines income inequality using a significantly wider variety of income inequality metrics than previous research.

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| **Authors** | **Data** | **Years** | **Type of income** | **Geography** | **Income Inequality Metric** |
| **Previous Research** |
| Piketty and Saez (2003) | IRS tax data | 1913-present | Pre-tax income for tax-unit | Nation | Top decile income shares |
| CBO (2011) | IRS tax data, CPS | 1979-2007 | Pre-tax, Pre-transfer and After-tax, after transfer (only federal taxes) | Nation | Gini IndexQuintile income shares |
| Burkhauser (2011) | CPS(internal Census) | 1975-2004 | Pre-tax, after-transfer | Nation | Gini Index |
| Gindelsky (2015) | CPS | 1975-2014 | Pre-tax, pre-transfer income (households and individuals) | Nation | Top 1% income shareTop 0.1% income shareGini IndexGini Index of Top 1% |
| Meyer and Sullivan (2013) | CPS | 1963-2011 | Pre-tax, Pre-transfer and After-tax, after-transfer (state and federal taxes) | Nation | 90-10 Ratio, 90-50 Ratio, 50-10 Ratio |
| Heathcote, Perri, and Violante (2009) | CPS | 1965-2005 | Pre-tax, Pre-transfer and After-tax, after-transfer(only federal taxes) | Nation | Variance of Log, Gini Index, 50-10 Ratio, 90-50 Ratio |
| McNichol et al. (2012) | CPS | 1977-2010 | Pre-tax, Pre-transfer and After-tax, after-transfer(only federal taxes) | Nation | 80-20 Ratio, 95-20 Ratio, 90-50 Ratio, 95-50 Ratio |
| Gottschalk and Danziger (2005) | CPS | 1975-2002 | Pre-tax, pre-transfer income | Nation | 90-10 Ratio |
| Cunningham (2015) | OES | 2003-2013 | Wages | MSA | 90-10 Ratio |
| Weinberg (2011) | 5-year ACS | 2005-2009 | Pre-tax, after-transfer | Nation, State, and MSAs with pop >1 million | Gini Index, 90-10 Ratio, 95 -20 Ratio |
| Mather and Jarosz (2014) | Decennial Census, 5-year ACS | 1989-2012 | Pre-tax, after-transfer | Counties | Gini Index |
| Holmes and Berube (2016) | 1-year ACS | 2007-2014 | Pre-tax, after-transfer | 100 most populous MSAs | 95-20 Ratio |
| **Current paper** |
| Glassman (2016) | 1-year ACS(internal Census) | 2005-2015 | Pre-tax, Pre-transfer and After-tax, After-transfer(state and federal taxes) | Nation, MSA | Quintile income shares, Gini Index, Theil Index, MLD, Palma Ratio, 80-20 Ratio, 90-10 Ratio, 50-10 Ratio, 90-50 Ratio, 99-90 Ratio |

**Data**

The data in this paper comes from the 2005 through 2015 American Community Survey one-year estimates.[[1]](#footnote-1) This research is restricted to heads of households who live in an identifiable Metropolitan Statistical Area (MSA)[[2]](#footnote-2). There were 352 MSAs in 2005 and 381 MSAs in 2015. However, 26 Micropolitan Statistical Areas in 2005 were MSAs in 2015. Three MSAs in 2015 were not MSAs in 2005 and were not Micropolitan Statistical Areas: California-Lexington Park, MD; Crestview-Fort Walton Beach-Destin, FL; and Sebastian-Vero Beach, FL. In order to have a balanced dataset over the entire time period, these three MSAs were excluded and a total of 378 MSAs were used. All coefficients are calculated using household weights and standard errors are calculated using replicate weights.

The main variable of interest throughout the paper is household income. Two measures of household income are used: pre-tax, pre-transfer income and after-tax, after-transfer income. Pre-tax, pre-transfer income includes wage and salary income, self-employment income, retirement income, and interests and dividends.

After-tax, after-transfer income includes cash transfer payments (Supplemental Security income, Social Security, and cash public assistance) and subtracts federal and state taxes using the National Bureau of Economic Research’s TAXSIM program[[3]](#footnote-3) for each year.[[4]](#footnote-4) Due to tax credits, it is possible for taxes to be negative, which means that income increases for these households after taxes are taken into account. For the purposes of this paper, government programs are defined as state and federal income taxes and cash transfer payments.[[5]](#footnote-5)

The difference in household size is adjusted for by using the following three-parameter equivalence scale, which is the same equivalence scale used in the supplemental poverty measure[[6]](#footnote-6):

 One and two adults:

 Single parents:

 All other families:

where *adults* is the number of adults in the household, *first child* is equal to one if the household has at least one child, *other children* is equal to the number of children in the household minus one, and *children* is the number of children in the household.

Income is divided by this scale variable to get a measure of equivalence adjusted household income. Finally, income is adjusted by MSA cost of living (COL) using regional price parities (RPPs) developed by the Bureau of Economic Analysis (BEA).[[7]](#footnote-7) RPPs are based on prices of a variety of items from the Consumer Price Index, such as food, transportation, and education, as well as rents obtained from the ACS.[[8]](#footnote-8) These prices and rents are used to create an index, which compares each MSA price level to the national price level.

**The Effect of Government Programs**

There is one important caveat to keep in mind when thinking about the effect of government programs from 2005 to 2015. There were some changes to federal income tax policies during this time. In 2009, the Earned Income Tax Credit was expanded to cover more families and provide larger benefits. In 2013, a new top tax bracket of 39.6 percent was added on top of the previous top tax bracket of 35 percent. Both of these policy changes serve to reduce income inequality by providing benefits to those at the lower end of the income distribution and decreasing disposable income of those at the upper end of the income distribution. This caveat means that some of what is captured in the analysis is a change over time in the effect of government programs and some is the effect of the change in the government programs themselves.

The household income cut-off points, or quintile limits, used to calculate the income shares for 2005 and 2015 are listed in Table 1. The first quintile includes all households with income below the cut-off value listed under First. The second quintile includes all households with income between the first cut-off value and the second cut-off value. The third quintile includes all households with income between the second cut-off value and the third cut-off value. The fourth quintile includes all households with income between the third cut-off value and the fourth cut-off value. The fifth quintile includes all households with income above the fourth cut-off value. The top one percent includes all households with incomes above the top one percent cut-off value.

For both years, the cut-off values are larger when government programs are included in household income for the first and second quintile limits and smaller when government programs are included in household income for the third and fourth quintile limits. Before examining the quintile shares in Table 3, one can already see that government programs increase disposable incomes for households in the bottom of the income distribution and decrease disposable incomes for households at the top of the income distribution.

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| **Table 1: Household Income Cut-off Values for Quintiles and Top One Percent** |
|  | **20051** | **20151** |
|  | **Pre-tax, Pre-transfer** | **After-tax, After-transfer** | **Pre-tax, Pre-transfer** | **After-tax, After-transfer** |
| **Quintile Limit** | **Income** | **Std. Err** | **Income** | **Std. Err** | **Income** | **Std. Err** | **Income** | **Std. Err** |
|  **First** | 11,088 | 30.66 | 16,360 | 29.98 | 9,914 | 21.61 | 16,356 | 20.20 |
|  **Second** | 25,268 | 45.90 | 27,187 | 36.06 | 24,336 | 27.51 | 27,449 | 26.18 |
|  **Third** | 40,950 | 66.76 | 39,049 | 22.29 | 41,095 | 56.10 | 40,226 | 35.88 |
|  **Fourth** | 64,080 | 69.61 | 55,931 | 58.37 | 66,518 | 45.53 | 58,727 | 46.12 |
| **Top 1%** | 230,527 | 1,146.32 | 166,654 | 773.64 | 257,456 | 1,114.16 | 184,873 | 615.89 |
| 1 All numbers are in 2015 dollars.Source: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

In Tables 2 and 3, the immediate takeaway is that the effect of government programs on income inequality has increased over time. In Table 2, nine income inequality metrics are listed based on the percent change in the difference between pre-tax, pre-transfer income inequality and after-tax, after-transfer income inequality from 2005 to 2015.[[9]](#footnote-9) Each difference between pre-tax, pre-transfer and after-tax, after-transfer income inequality is positive and statistically significant. This means that income inequality is higher before taxes and transfers are taken into account for each metric.

Furthermore, each change in metric over the time period is positive and statistically significant. This means that there is a widening gap for each income inequality metric between the different measures of household income.

Although there is an increase over time in the difference in income inequality between pre-tax, pre-transfer income and after-tax, after-transfer income, this increase varies significantly across the different metrics. Looking at the extremes, there is a 23 or 24 percent increase in the effect of taxes and transfers on household income inequality over the time period when income inequality is measured using the 90-10 Ratio or Palma Ratio respectively[[10]](#footnote-10), but this percentage increase is only 9 percent when income inequality is measured using the Gini Index.

The largest change in metric over time occurs with the Palma Ratio and the 90-10 Ratio, which are metrics that focus on the differences between the top and the bottom of the income distribution. It makes sense that the biggest changes would happen with these since taxes are progressive in nature and transfers are significantly more likely to go to those in the bottom of the distribution. The Gini Index being last makes sense as well since previous studies have found that the metric is insensitive to changes in the extremes of the income distribution.

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| **Table 2: Difference between pre-tax, pre-transfer metric and after-tax, after-transfer metric over time** |
|  | **2005** | **2015** | **Change in metric** |
|  | **Difference1** | **Std. Err** | **Difference1** | **Std. Err** | **Percent** | **Std. Err** |
| **Palma** | 0.93662\* | 0.00672 | 1.16537\* | 0.00511 | 24.42\* | 1.04622 |
| **90-10** | 5.33983\* | 0.00113 | 6.57481\* | 0.00112 | 23.13\* | 0.03345 |
| **80-20** | 1.22662\* | 0.00026 | 1.48699\* | 0.00025 | 21.23\* | 0.03278 |
| **MLD** | 0.16904\* | 0.00207 | 0.20230\* | 0.00203 | 19.68\* | 1.89470 |
| **90-50** | 0.35854\* | 0.00008 | 0.42521\* | 0.00007 | 18.59\* | 0.03289 |
| **50-10** | 1.62237\* | 0.00020 | 1.89466\* | 0.00018 | 16.78\* | 0.01818 |
| **Theil** | 0.12161\* | 0.00198 | 0.14121\* | 0.00157 | 16.12\* | 2.28931 |
| **99-90** | 0.34884\* | 0.00018 | 0.39800\* | 0.00014 | 14.09\* | 0.07125 |
| **Gini** | 0.06867\* | 0.00072 | 0.07477\* | 0.00057 | 8.88\* | 1.41149 |
| 1 pre-tax, pre-transfer metric – after-tax, after-transfer metric. Therefore, a positive difference means that income inequality is higher before taxes and transfers are accounted for.\*Significant at the 90 percent confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

In Table 3, quintile income shares and top one percent income shares are used in place of income inequality metrics. These shares are a metric that allow one to look at where and how the income distribution is changing over time. There are several things one can learn from this table. First, not all the differences between pre-tax, pre-transfer and after-tax, after-transfer income shares are of the same sign. Including taxes and cash transfer payments in household income increases the income shares for the bottom four quintiles and decreases the income share of the top quintile and the top one percent.

Second, all the changes in the shares over time, except for the fourth quintile, are positive and statistically significant. This means that the difference between pre-tax, pre-transfer and after-tax, after-transfer income shares has widened over time.

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| **Table 3: Difference between pre-tax, pre-transfer income share and after-tax, after-transfer income share over time** |
|  | **2005** | **2015** | **Change** |
| **Quintiles** | **Difference1** | **Std. Err** | **Difference1** | **Std. Err** | **Percent** | **Std. Err** |
|  **First** | -0.01754\* | 0.00018 | -0.01822\* | 0.00013 | 3.88\* | 1.29835 |
|  **Second** | -0.01865\* | 0.00038 | -0.02025\* | 0.00030 | 8.58\* | 2.73532 |
|  **Third** | -0.01350\* | 0.00055 | -0.01565\* | 0.00051 | 15.93\* | 6.04793 |
|  **Fourth** | -0.00352\* | 0.00086 | -0.00517\* | 0.00082 | 46.88 | 42.78266 |
|  **Fifth** | 0.05321\* | 0.00228 | 0.05929\* | 0.00187 | 11.43\* | 5.92848 |
| **Top 1%** | 0.02040\* | 0.00141 | 0.02439\* | 0.00120 | 19.57\* | 10.14345 |
| 1 pre-tax, pre-transfer income share – after-tax, after-transfer income share. Therefore, a positive difference means that the income share is higher before taxes and transfers are accounted for and a negative difference means that the income share is lower before taxes and transfers are accounted for.\*statistically significant at 90 percent confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

 Tables 2 and 3 show how the effect of government programs on income inequality has increased over time. However, these tables do not tell one much about how income inequality has changed over time, how these changes vary by metric, and where in the income distribution these changes occurred.

**Income inequality metrics over time: 2005 vs. 2015**

 In Table 4, the income inequality estimates are displayed for each metric for pre-tax, pre-transfer household income. This measure of household income is important because it shows what income inequality would look like if government programs were not in place.

Each metric is measured on a different scale so the estimates cannot be directly compared. However, the percent change in the metrics from 2005 to 2015 can be compared. The first thing to notice is that every metric had a statistically significant and positive percentage change over the time period. This means that every metric shows that pre-tax, pre-transfer household income inequality increased from 2005 to 2015.

 Despite this similar pattern, the size of the increase shown by each metric differs significantly. Using this table, one can conclude that income inequality increased from 2005 to 2015 anywhere from four percent, if income inequality is measured using the Gini Index, to nearly sixteen percent, if income inequality is measured using the MLD, or somewhere in-between.

 One final point is to look at where changes in the income distribution are taking place by examining the non-overlapping income ratios: the 50:10 ratio, the 90:50 ratio, and the 99:90 ratio. The biggest increase was in the 50:10. This means that the median household moving further away from households at the bottom of the income distribution (50-10 ratio) is a more important factor for why income inequality is increasing than households at the top of the income distribution moving further away from the median (90-50 ratio) when excluding taxes and transfers from household income. Similarly, the widening gap in the lower half of the income distribution is a more important factor than the widening gap at the top of the income distribution (99-90 ratio).

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| **Table 4: Pre-tax, Pre-transfer income Inequality metric over time: Rank ordered** |
|  | **2005** | **2015** | **Change in metric** |
|  | **Est** | **Std. Err** | **Est** | **Std. Err** | **Percent** | **Std. Err** | **Rank** |
| **MLD** | 0.55188\* | 0.00158 | 0.63926\* | 0.00158 | 15.83\* | 0.43811 | 1 |
| **Palma** | 2.76433\* | 0.00502 | 3.15459\* | 0.00379 | 14.12\* | 0.24848 | 2 |
| **90-10** | 12.41080\* | 0.00107 | 14.06865\* | 0.00107 | 13.36\* | 0.01303 | 3 |
| **Theil** | 0.41085\* | 0.00166 | 0.45436\* | 0.00133 | 10.59\* | 0.55177 | 4 |
| **80-20** | 4.64534\* | 0.00024 | 5.07763\* | 0.00023 | 9.31\* | 0.00751 | 5 |
| **50-10** | 4.78888\* | 0.00019 | 5.12465\* | 0.00016 | 7.01\* | 0.00540 | 6 |
| **90-50** | 2.59159\* | 0.00007 | 2.74529\* | 0.00006 | 5.93\* | 0.00368 | 7 |
| **99-90** | 2.61956\* | 0.00015 | 2.77103\* | 0.00012 | 5.78\* | 0.00759 | 8 |
| **Gini** | 0.46054\* | 0.00055 | 0.47951\* | 0.00044 | 4.12\* | 0.15681 | 9 |
| \*Significant at the 90 percent confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

Table 5 displays income inequality estimates derived from after-tax, after-transfer household income. Since after-tax, after-transfer household income measures the resources households have available to spend, the estimates in Table 5 are more informative than the estimates in Table 4 in helping us understand the economic well-being of households as well as the impact of government policy.

Just like Table 4, all metrics are positive and statistically significant and the size of the percent change in the metrics from 2005 to 2015 varies significantly by metric. Even after taxes and transfers are taken into account, each metric shows that income inequality increased from 2005 to 2015. However, the size of this increase ranges from two percent, if income inequality is measured using the 50-10 ratio, to fourteen percent if income inequality is measured using the MLD.

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| **Table 5: After-tax, after-transfer income Inequality metric over time: Rank ordered** |
|  | **2005** | **2015** | **Change in metric** |
|  | **Est** | **Std. Err** | **Est** | **Std. Err** | **Percent** | **Std. Err** | **Rank** |
| **MLD** | 0.38284\* | 0.00134 | 0.43696\* | 0.00128 | 14.14\* | 0.52094 | 1 |
| **Palma** | 1.82771\* | 0.00446 | 1.98921\* | 0.00343 | 8.84\* | 0.32520 | 2 |
| **Theil** | 0.28924\* | 0.00086 | 0.31315\* | 0.00083 | 8.27\* | 0.43124 | 2 |
| **90-10** | 7.07097\* | 0.00036 | 7.49384\* | 0.00033 | 5.98\* | 0.00713 | 4 |
| **80-20** | 3.41872\* | 0.00011 | 3.59064\* | 0.00010 | 5.03\* | 0.00447 | 5 |
| **99-90** | 2.27072\* | 0.00011 | 2.37302\* | 0.00008 | 4.51\* | 0.00617 | 6 |
| **90-50** | 2.23305\* | 0.00004 | 2.32008\* | 0.00004 | 3.90\* | 0.00258 | 7 |
| **Gini** | 0.39189\* | 0.00046 | 0.40474\* | 0.00035 | 3.28\* | 0.15058 | 8 |
| **50-10** | 3.16651\* | 0.00008 | 3.22999\* | 0.00007 | 2.00\* | 0.00340 | 9 |
| \*Significant at the 90 percent confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

More interestingly, there are significant differences in the percentage changes in income inequality over time based on the measure of household income used (Table 4 vs. Table 5). First, the percentage change over time in Table 4 is larger than the percentage change over time in Table 5 for each metric and these differences are statistically significant. Therefore, income inequality has not increased as much over time when household income taxes and cash transfers are accounted for regardless of the income inequality metric used.

Second, there were some interesting changes in the non-overlapping ratios. Their relative order changed. The 50-10 ratio showed the largest increase of the three in Table 4 while it showed the smallest increase of the three in Table 5. The 99-90 ratio also reversed its rank ordering, from the smallest percent increase (rank 8 in Table 4) to the largest percent increase (rank 6 in Table 5) among these three ratios. This tells us that government programs affected the 50-10 ratio the most and the 99-90 ratio the least of the three non-overlapping ratios. In fact, the 50-10 ratio changed from 6th in Table 3 to 9th in Table 5. Income inequality only increased by two percent from 2005 to 2015 when measured by the 50-10 ratio and household income accounts for taxes and transfers.

 To delve further into where the changes in income inequality are taking place, Tables 6 and 7 display the household income shares for pre-tax, pre-transfer income and after-tax, after-transfer income respectively. There are two main points about the quintile results in these tables. The first is that the bottom four quintiles each decreased in terms of share of income from 2005 to 2015 for pre-tax, pre-transfer income and the bottom three quintiles decreased in terms of share of income from 2005 to 2015 for after-tax, after-transfer income. Furthermore, the top quintile increased its share of the income from 2005 to 2015 for both types of household income.

 The biggest change by a significant margin occurred in the first quintile for both types of income. Therefore, the largest contributor to the observed increase in income inequality was the decrease in income share held by the bottom twenty percent of the income distribution. For both types of income, the smallest percentage change in income share occurred for households in the fourth quintile. While these households did lose income share over the time period, they lost significantly less than households in the lowest twenty percent. The top one percent income share increased significantly more than the top quintile. Gains in income by households in the top one percent of the distribution are a driving force in the top quintile gaining income share over time.

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| **Table 6: Pre-tax, pre-transfer income shares over time** |
|  | **20051** | **2015** | **Change in metric** |
| **Quintiles** | **Est** | **Std. Err** | **est** | **Std. Err** | **Percent** | **Std. Err** |
|  **First** | 0.03043\* | 0.00009 | 0.02718\* | 0.00007 | -10.68\* | 0.35029 |
|  **Second** | 0.09016\* | 0.00026 | 0.08400\* | 0.00020 | -6.83\* | 0.34842 |
|  **Third** | 0.15126\* | 0.00039 | 0.14513\* | 0.00035 | -4.05\* | 0.33873 |
|  **Fourth** | 0.22957\* | 0.00061 | 0.22659\* | 0.00057 | -1.30\* | 0.36115 |
|  **Fifth** | 0.49857\* | 0.00179 | 0.51711\* | 0.00146 | 3.72\* | 0.47373 |
| **Top 1%** | 0.08759\* | 0.00113 | 0.09633\* | 0.00097 | 9.98\* | 1.79986 |
| \*Significant at the 90 percent confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

The second point is that the changes in the income shares for each quintile are larger in percentage terms for the first three quintiles in Table 6 compared to Table 7. The biggest difference was in the first quintile. Government programs helped households in the bottom twenty percent of the income distribution the most. There were no significant differences in the fourth and fifth quintiles. These households are not the beneficiaries of most cash transfer payments or the progressive tax system.

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|  **Table 7: After-tax, after-transfer income shares over time** |
|  | **2005** | **2015** | **Change in metric** |
| **Quintiles** | **Est** | **Std. Err** | **est** | **Std. Err** | **Percent** | **Std. Err** |
|  **First** | 0.04798\* | 0.00015 | 0.04541\* | 0.00011 | -5.36\* | 0.37431 |
|  **Second** | 0.10881\* | 0.00028 | 0.10425\* | 0.00022 | -4.19\* | 0.31885 |
|  **Third** | 0.16477\* | 0.00038 | 0.16078\* | 0.00037 | -2.42\* | 0.31791 |
|  **Fourth** | 0.23309\* | 0.00061 | 0.23175\* | 0.00059 | -0.57 | 0.36301 |
|  **Fifth** | 0.44536\* | 0.00141 | 0.45782\* | 0.00117 | 2.80\* | 0.41826 |
| **Top 1%** | 0.06719\* | 0.00084 | 0.07194\* | 0.00071 | 7.07\* | 1.70540 |
| \*Significant at the 90% confidence levelSource: 2005 and 2015 American Community Survey. For more information on the ACS, see census.gov/acs. |

**Income inequality metrics over time: 2005 through 2015**

Tables 4 through 7 show that income inequality has increased over time. However, these tables just compare two years while ignoring the full pattern over the time period. In this section, tables illustrate the different income inequality metrics covering the period from 2005 through 2015. I only show tables for after-tax, after-transfer household income in Table 8 and Table 9, but I note the metrics in each table that had different changes for pre-tax, pre-transfer household income.

 In Table 8, a plus sign is listed if there was a statistically significant increase at the ninety percent confidence level in the income inequality metric, a minus sign is listed if there was a statistically significant decrease at the ninety percent confidence level in the income inequality metric, and a blank space occurs if there was no statistically significant change at the ninety percent confidence level in the income inequality metric listed. To make all the information in the table easier to digest, the table is divided into three sections: summary measures, income ratios, and non-overlapping income ratios.

1. **Summary Measures**

 In Table 5, I observed that from 2005 to 2015 each of the three metrics showed an overall increase in income inequality. While this trend is apparent in each of the three measures in Table 8, income inequality was decreasing during several years. For all three metrics, income inequality increased from 2007 to 2008, decreased from 2008 to 2009, increased from 2009 to 2011, decreased again from 2013 to 2014, and increased from 2014 to 2015.

 The differences in the measures occurred in the beginning of the series. From 2005 to 2006, the Gini Index showed an increase, the MLD showed a decrease, and the Theil Index showed no significant change in income inequality. From 2006 to 2007, the Gini Index showed a decrease and the MLD and Theil Index showed increases in income inequality.

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| Table 8: Changes in After-tax, After-transfer Household Income Inequality |
|  |   | **2005-2006** | **2006-2007** | **2007-2008** | **2008-2009** | **2009-2010** | **2010-2011** | **2011-2012** | **2012-2013** | **2013-2014** | **2014-2015** |
| Summary Measures | Gini | **+ 3** | **- 1** | **+** | **- 1** | **+ 2** | **+** |  | **+** | **-** | **+** |
| Theil |  | **+** | **+** | **- 1** | **+ 2** | **+** |  | **+** | **-** | **+** |
| MLD | **-** | **+ 3** | **+** | **- 1** | **+ 2** | **+** |  | **+** | **-** | **+** |
| Distribution- wide Income Ratios | 80-20 | **-** | **-** | **+** | **- 1** | **+ 2** | **+** | **-** | **- 1** | **-** | **+** |
| Palma |  **2** | **+** | **+** | **- 1** |  **+ 2** | **+** |  | **+** | **-** | **+** |
| 90-10 | **-** | **-** | **+** | **- 1** | **+ 2** | **+** | **+** | **+** | **-** | **+** |
| Non-overlapping Income Ratios | 50-10 | **-** | **-** | **+** | **- 1** | **+ 2** | **+** | **+** | **- 1** | **-** | **+** |
| 90-50 | **-** | **+** | **+** | **- 1** | **+ 2** | **+** | **- 1** | **+** | **-** | **+** |
| 99-90 | **+** | **+** | **+** | **-** | **-** | **+** | **+** | **+** | **-** | **+** |
| Source: 2005 through 2015 American Community Survey. For more information on the ACS, see census.gov/acs.1 Change is positive for pre-tax, pre-transfer household income inequality2 Change is negative for pre-tax, pre-transfer household income inequality3 No significant change for pre-tax, pre-transfer household income inequality |

1. **Distribution-wide Income Ratios**

Similar to the summary measures, the distribution-wide income ratios each show an overall increase in income inequality from 2005 to 2015, but income inequality decreased during certain years. Income inequality decreased for all three income ratios from 2008 to 2009 and from 2013 to 2014. From 2005 to 2007, income inequality decreased for the 80-20 ratio and the 90-10 ratio, but the Palma ratio showed no significant change in income inequality from 2005 to 2006 and an increase in income inequality from 2006 to 2007. The 80-20 ratio also showed a decrease in income inequality from 2011 to 2013, while the other two ratios showed no significant change or an increase in income inequality during these years.

1. **Non-overlapping Income Ratios**

Since these ratios measure different parts of the income distribution, it may not be surprising that there are more differences among these ratios than among the summary measures or distribution-wide income ratios. All three ratios showed increases in income inequality from 2007 to 2008, 2010 to 2011, and 2014 to 2015 and all three showed decreases in income inequality from 2008 to 2009 and 2013 to 2014. In the remaining years, income inequality changed in different directions at different parts of the distribution. From 2006 to 2007 and 2012 to 2013, income inequality increased in the top half of the distribution (90-50 ratio and 99-90 ratio) and decreased in the bottom half of the distribution (50-10 ratio). From 2005 to 2006 and from 2009 to 2010, income inequality in the top of the distribution (99-90 ratio) changed in a different direction from income inequality in the rest of the distribution (90-50 ratio and 50-10 ratio). From 2011 to 2012, income inequality in the top half of the distribution (90-50 ratio) decreased while income inequality in the bottom half of the distribution (50-10 ratio) increased.

1. **Household Income Shares**

In Table 9, I present the income shares for each quintile as well as the income share for the top one percent. In Table 7, I showed that the overall percentage change in income shares from 2005 to 2015 was negative for the bottom three quintiles and there was no significant change in income share for the fourth quintile. However, the income share of households in the bottom quintile increased from 2005 to 2006, 2008 to 2009, and 2013 to 2014.The income share of households in the second and third quintiles increased from 2008 to 2009 and 2013 to 2014.Finally, the income share of households in the fourth quintile increased from 2008 to 2010.

Table 7 also showed that the overall percentage change in income shares was positive for the top quintile and for the top one percent. However, the income share of households in the top quintile decreased from 2008 to 2009 and 2013 to 2014. The income share of households in the top one percent decreased from 2008 to 2009 and 2013 to 2014.

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| Table 9: Changes in After-tax, After-transfer Household Income Shares |
| Quintiles | **2005-2006** | **2006-2007** | **2007-2008** | **2008-2009** | **2009-2010** | **2010-2011** | **2011-2012** | **2012-2013** | **2013-2014** | **2014-2015** |
|  First | **+** | **2** | **-** |  **+ 2** | **- 1** | **-** | **2** | **2** | **+** | **-** |
|  Second |  |  **- 3** | **-** |  **+ 2** | **- 1** | **-** | **2** | **2** | **+** | **-** |
|  Third |  | **-** |  **- 3** |  **+ 3** |  |  **- 3** |  | **-** | **+** | **-** |
|  Fourth |  | **-** |  | **+** |  **+ 3** |  |  | **-** | **1** | **-** |
|  Fifth |  | **+** |  **+ 3** |  **- 1** | **2** |  **+ 3** |  | **+** | **-** | **+** |
| Top 1% |  | **+** |  **+ 3** |  **- 3** |  |  |  | **1** | **-** | **+** |
| Source: 2005 through 2015 American Community Survey. For more information on the ACS, see census.gov/acs.1 Change is positive for pre-tax, pre-transfer household income.2 Change is negative for pre-tax, pre-transfer household income.3 No significant change for pre-tax, pre-transfer household income. |

1. **Discussion**

Although income inequality increases overall from 2005 to 2015, there were two period in which every income inequality metric in Table 8 decreased: the 2008-2009 period and the 2013-2014 period. Table 9 can help explain this. In the 2008-2009 period, there was an increase in the share of after-tax, after-transfer household income for the bottom four income quintiles and there was a decrease in the share of income for the top quintile. A similar thing happened in 2013-2014, except that there was no significant change in the income share of households in the fourth quintile.

 In both periods, the bottom eighty percent of the income distribution gained income share and the top twenty percent, and the top one percent, lost income share. This did not happen in any other time period and, consequently, there is no such agreement among all the income inequality metrics in any other time period.

 Conversely, all nine income inequality metrics in Table 8 increased in the 2007-2008, 2010-2011, and 2014-2015 time periods. This is explained in Table 9 where the bottom four quintiles either lost income share or had no significant change in income share and the top quintile gained income share.

**Income Inequality over time by MSA: 2005 vs. 2015**

 Income inequality increased for the United States from 2005 to 2015 according to each income inequality metric. However, all MSAs did not experience this same increase. In Figure 1, each metric is divided into MSAs that had decreases in income inequality, no statistically significant change in income inequality, and increases in income inequality from 2005 to 2015.

 There are several points to make about this figure. First, despite the overall increase in income inequality for the country, income inequality decreased in some MSAs and income inequality did not significantly change over time in others.[[11]](#footnote-11)

 Second, the mix of changes in income inequality for MSAs varied based on the income inequality metric used. A majority of MSAs had no significant change in income inequality when income inequality was measured with the Gini Index, the Theil Index, the MLD, and the Palma Ratio. However, a majority of MSAs had an increase in income inequality when income inequality was measured using the 80-20 Ratio, the 90-10 Ratio, and the three non-overlapping ratios.

 Third, significantly more MSAs had a decrease in the 50-10 ratio than had a decrease in the 90-50 ratio. In general, the top of the income distribution was moving away from the median and the bottom of the income distribution was moving closer to the median for households from 2005 to 2015.

 **I**n Figure 2, I look at income inequality in different parts of the income distribution among MSAs. Among the 218 MSAs that had an increase in income inequality in the bottom half of the income distribution (50-10 ratio), 44 MSAs had a decrease in the top half of the distribution (90-50 ratio), 58 MSAs had a decrease in the top of the income distribution (99-90 ratio), and 15 MSAs had an decrease in both (90-50 ratio and 99-90 ratio).

 Among the 134 MSAs that had a decrease in income inequality in the bottom half of the income distribution (50-10 ratio), 92 MSAs had an increase in income inequality in the top half of the distribution (90-50 ratio), 91 MSAs had an increase in income inequality in the top of the distribution (99-90 ratio), and 63 MSAs had an increase in both (90-50 ratio and 99-90 ratio).

 There are a large number of MSAs that had different changes happening over time to different parts of the income distribution. Over half of the MSAs that had a decrease in income inequality in the bottom of the distribution, had an increase in income inequality at the top of the distribution.

Taking Figure 1 and Figure 2 together, it is clear that there is significant variation in changes in income inequality from 2005 to 2015 among MSAs both in general and based on the metric used to measure income inequality.

**Conclusion**

 The main headline grabbing story is that income inequality has increased over the last decade. Many previous studies have found this to be the case and this paper is no different. However, this glosses over significant variations in changes in income inequality by income inequality metric, by type of income, by year, and by MSA.

 Income inequality increased over time according to each metric, but the size of the increase varied considerably. The increase in income inequality ranges from four percent to sixteen percent for pre-tax, pre-transfer income and from two percent to fourteen percent for after-tax, after-transfer income.

 There was a significant difference in how much income inequality changed based on the type of household income used. Pre-tax, pre-transfer income inequality increased significantly more than after-tax, after-transfer income inequality. The effect of government programs (taxes and transfers) increased over time as well.

 Income inequality grew between 2005 and 2015, but it was not a steady increase over the entire time period. For each metric, there were multiple years in which income inequality decreased or did not change significantly.

 While income inequality increased for the country from 2005 to 2015, there were many MSAs for which income inequality decreased or did not change significantly over that time period. Furthermore, there were differences in a number of MSAs between the direction of change of income inequality in the top of the income distribution and income inequality in the bottom of the distribution.

 This paper continues to be a work in progress. As such, I have several extensions of this paper that I plan for the future. Since there are 378 MSAs, it is not practical to look at each MSA in the same manner that I looked at the overall country. However, in the future, it would be instructive to look at how income inequality changed year by year for select MSAS.

It would also be useful to map the changes in income inequality to determine if there are any patterns to where MSAs with increases or decreases in income inequality are located. Finally, I could also compare pre-tax, pre-transfer income inequality with after-tax, after-transfer income inequality to find out if there are areas where government programs have more or less of an impact over time.

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1. For more information on the ACS, see census.gov/acs. [↑](#footnote-ref-1)
2. For information on metropolitan and micropolitan statistical areas, see https://www.census.gov/population/metro/about/. [↑](#footnote-ref-2)
3. Feenberg, Daniel Richard, and Elizabeth Coutts. 1993. “An Introduction to the TAXSIM Model*”. Journal of Policy Analysis and Management* 12(1): 189-194. http://www.nber.org/taxsim/. [↑](#footnote-ref-3)
4. This paper uses internal Census data, which is run through a local TAXSIM program. At this time, our internal TAXSIM has state and federal tax laws for 1977 to 2013. 2014 and 2015 data are run using 2013 state and federal income tax laws. [↑](#footnote-ref-4)
5. SNAP/food stamp benefits are not included. [↑](#footnote-ref-5)
6. Short, Kathleen. 2014. “The Supplemental Poverty Measure: 2013”. *Current Population Reports*. U.S. Census Bureau. [↑](#footnote-ref-6)
7. RPP’s are available for 2008 through 2013. 2013 RPP’s were used for 2014 and 2015. 2008 RPP’s were used for 2005, 2006, and 2007. [↑](#footnote-ref-7)
8. For more information about RPPs, see https://www.bea.gov/regional/pdf/RPP2016\_methodology.pdf. [↑](#footnote-ref-8)
9. Not all comparisons of percent changes by metrics are statistically significant. [↑](#footnote-ref-9)
10. The Palma Ratio and the 90-10 Ratio are not statistically significantly different. [↑](#footnote-ref-10)
11. Standard errors vary significantly across measures. The Gini Index, Theil Index, MLD, and Palma Ratio use all incomes directly and therefore have larger standard errors than the metrics that use percentile income ratio estimates (80-20, 90-10, 90-50, 50-10, 99-90). [↑](#footnote-ref-11)