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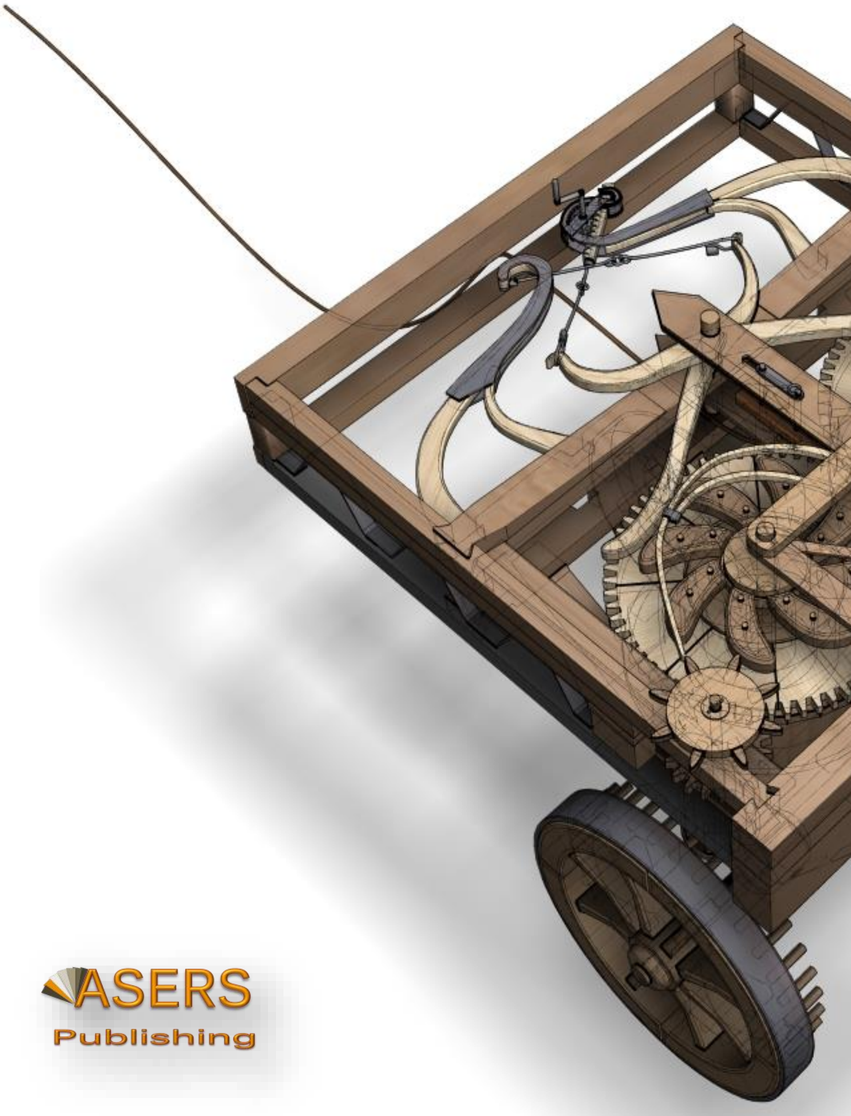

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ESTIMATES OF INCOME INEQUALITY ARE BIASED OR MISINTERPRETED

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Abstract:

We considerdefinitions and measuring procedures of personal income used by three U.S. agencies as well as the evolution of household size distribution and reveal major quantitative inconsistencies in the reported figures of personal and household inequality. The problem with the inequality estimates reported by the Internal Revenue Service consists in the changing proportion of people with lower incomes. The increasing proportion of low-income population is misinterpreted as the growth in income inequality. The Census Bureau provides personal income distributions scaled from a small subset of households to the whole population. Surprisingly, the Gini coefficient estimated from the Census Bureau data for people with income does not depend on the dramatic change in income definition in 1977, when the share of working age population with (likely low) incomes increased by 10%. When corrected to the population without income, the Gini coefficient demonstrates a significant decrease in 1978. The changing composition of households in the U.S. is the effect explaining the reported increase in Gini coefficientfor households since 1967. When corrected for actual decrease in the average household size the relevant Gini coefficient returns to that of personal incomes. According to the Census Bureau, the latter coefficient has been hovering in a very narrow range between 0.50 and 0.51 since 1974. Evaluating the evolution of labour and capital shares of the U.S. personal incomereported by the Bureau of Economic Analysis we found that the increasing share of income of the top 1% households does not affect the labour share income. The growth in the income share of richest families is related to the increasing share of the consumption of fixed capital which is converted into private money though the reduction in taxes on production and imports.

Keywords:income inequality, Gini coefficient, households

JEL Classification:D3

1. Introduction

There are three major agencies reporting various measures of personal income in the USA. The Census Bureau (CB) measures personal incomes in household surveys (CPS ASEC) at an annual rate (CB, 2006). This measure is called Money Income (MI) and includes a variety of personal income sources. The CB provides these estimates to the Bureau of Labor Statistics, also in form of personal/household/family distributions. The Bureau of Economic Analysis (BEA) carries out annual estimates of (gross) personal income (GPI) as based on administrative records, censuses, and similar surveys, but it does not provide fine structured income distributions (BEA, 2012). The BEA reports aggregate income figures and does not allow inferring the evolution of personal or household income distribution in time. The most important similarities and differences of the CB and BEA measures are discussed in depth in (CB, 2012). The Internal Revenue Service (IRS) also measures and reports personal incomes filed for tax purposes. Since 1996, the IRS has been publishing electronic tables of personal incomes distribution (IRS, 2012). This is similar but somewhat different from the CB's reports. Due to intrinsic inconsistencies in definition and methodology of measurements, the measures of income inequality provided by these three agencies are subject to bias. In this paper, we demonstrate a few examples of bias and even misinterpretation of income inequality measurements.

2. Bias in income inequality measures. Census Bureau and Internal Revenue Services

From the point of view of scientific methodology, different purposes and measuring procedures used by three agencies reporting personal incomes make it difficult to follow up the actual evolution of income distribution and income inequality in the U.S. in quantitative terms. As a result, there is no comprehensive definition or measure of personal/household/family income and its distribution. Moreover, there is no way to merge all data in one consistent table, to estimate the distribution of income over age/race/sex, and to calculate quantitative measures of inequality like the Gini coefficient. It is possible to illustrate the level of difficulties associated with the introduction of a unified personal income distribution in two simple plots. Figure 1a shows the portion of personal incomes in the U.S. nominal GDP as reported by three agencies. Currently, the BEA reports as the (Gross) Personal Income (GPI) around 85% of the estimated nominal GDP. TheGPI covers almost all incomes included in the definition of national income. The IRS reports thetotal portion of personal incomes in the GDP fluctuating between 55% and 64% (i.e. ~10%) since 1996. The CB also demonstrates a decrease from 63% in 2000 to 57% in 2008 in the portion of personal income in the GDP, while having large differences from the IRS in income sources. It is worth noting that the IRS portion of the GDP is subject to strong variations, apparently, related to the rate of economic growth. The total personal income reported by the CB reveals no link to economic conditions but rather to the introduction of new definitions of income and measuring procedures in 2003.

The BEA provides no population estimates as related to its measures of personal incomes and Figure 1b shows two curves representing the proportions of population with income as defined by the CB and IRS. The IRS population was 45% in 2004 and 48% in 2008 with the respective total personal income of 57% and 62%. The CB reports that the proportion of population with income has been falling from 71% in 2000 to 69% in 2010 together with a proportional fall in the CB's total personal income. The difference of 30% in population share between two agencies is a dramatic one. The IRS does not count as personal (at least) those incomes which 30% of the total population defines as money income. The incomes ignored by the IRS seemto be generally small as producing negligible differences in the estimates of total personal income, but these incomes are extremely important for measures of income inequality. By excluding 30% of population when calculating the Gini coefficient one obtains a severely biased inequality estimate. On the contrary, the overall consistency of the household set and controlled changes in measurement methodology may provide less biased estimates of income inequality.

In practical and theoretical terms, the measured differences in the proportions of population and income definition are crucial. To measure personal/household incomes in the U.S., the Census Bureau conducts annual surveys (the March Current Population Surveys) covering a set of householdscarefully selected fromthe whole population. This scientifically designed set has to provide consistentmeasurements of incomes over time and one can carry out reliable quantitative analysis of principal characteristics of income inequality and their evolution. The IRS measures incomes of a randomly changing portion of the whole population driven by changing rules of taxation and by unpredictable times of economic crisis.

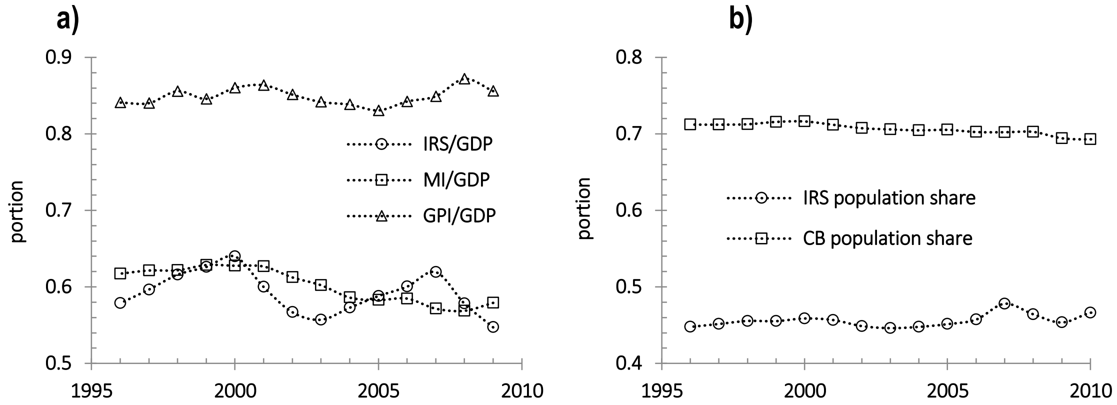

Figure 1. a) Portion of personal income in GDP: Internal Revenue Service (IRS), Money Income (MI) measured by the Census Bureau, and (Gross) Personal Income (GPI) measured by the Bureau of Economic Analysis. b) The proportion of people in total population counted as having personal income by the IRS and CB.

In the CPS, there exists a well-know problem with "top-coded" incomes -if the individual interviewed has earnings higher than \$999,999, those earnings are recorded simply as \$999,999. However, this artificial limit does not affect the accuracy of estimates of income in the richest group and the related measures of income inequality. In the estimates of Gini coefficient, the CB considers the highest personal incomes as distributed according to the Pareto (power) law. One can accurately approximate the actual, biased by “top-coding”, measurements by a theoretical curve. Figure 2 depicts two Pareto distributions (straight lines in the log-log axes) for the CPS and IRS personal income data. The IRS data set contains actual values of incomes “top-coded” in the CPS, which do not demonstrate statistically significant deviation from the Pareto law in the highest income range (R2=0.996). As a matter of fact, we do not need to measure any personal income in the high-income group. It is just enough to estimate the number of persons with income above some given (high enough) threshold, with the total income in this group playing the role of quantitative constraint. Then, one can use a simple power function for accurate estimates of population density at any income level and also total income above any threshold. Since 2003, the CB has been using the Pareto law interpolation of high-income data for the calculations of Gini coefficient.

The effect of changing population basis is also observed in the CPS income data (Census Bureau, 2006). The proportion of people with income changes over time (see Figure 3a). It was increasing in the 1950s through 1970s due to strong growth in the women's rate of participation in labour force. It has been falling since 1990, however. The CB reports the estimates of Gini coefficient since 1993 as related to the introduction of new income definitions and questionnaire. We have estimated the Gini coefficient for population with income since 1947 using the CPS data published by the Census Bureau (Kitov, 2009). Solid line presents the estimates published by the Census Bureau which are obtained for people with income. Both curves are depicted in Figure 3b and demonstrate an insignificant difference (less than 0.01) likely associated with some intrinsic differences in calculation methods. The Gini coefficient for people with income reveals a large degree of stability since the 1960s, which implies that the Lorentz curve, i.e. the underlying dimensionless distribution of personal income, does not depend on the proportion of population with income. Surprisingly, the personal income distribution repeats itself for any proportion of population with income.

When more than 30,000,000 people with zero income are added one should expect a dramatic increase in Gini coefficient. Essentially, thirteen per cent of working population has zero income what shifts the Lorenz curve further from the bisecting line. Figure 3b shows that, when people without income are included in calculations of income inequality, the Gini coefficient (for personal incomes) actually has been intensively falling since 1947 due to strong growth of the proportion of people with income. In 1993, the Gini coefficient for the whole working age population started to grow again in accordance with the increasing proportion of people without income. Currently, the personal income inequality in the U.S. is likely higher than the Census Bureau reports: the Gini coefficient is rather 0.58. This estimate is justified by the broader consideration of measurements adopted in hard sciences. In terms of physics, it is a mistake to neglect a substantial part of the full ensemble (closed system) when calculating aggregate variables. All aggregates based on portions of the full ensemble are intrinsically biased and cannot characterize the system and its behaviour. Hence, one must include people without income in inequality estimates. Otherwise, all inequality measures are biased by fluctuating shares of total income and population.

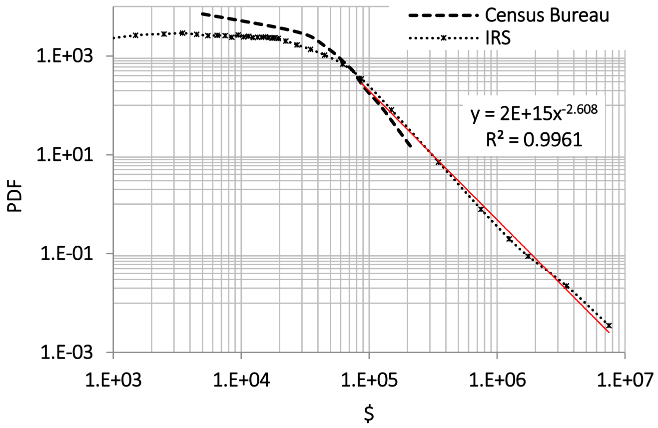

Figure 2. Population density functions (PDF) [number of people per $1 as a function of income for the estimated obtained by the IRS and CB in 2001.

Notice log-log scale. The Pareto law for higher incomes is an accurate approximation. Linear regression gives R^2=0.996 for incomes between $70,000 and $10,000,000. The regression line is shown by red.

Now we focus on some problems with the IRS measures of income which may result in biased estimates of inequality.The main problem of the IRS income definition consists inthe floating low-end income threshold. The population used for inequality calculation fluctuates randomly or according to some predetermined relationship (*e.g.*, tax code).So, one can suggest that the driving force behind the increasing personal income inequality, as reported by the IRS, likely consist in biased measurements and inconsistent definitions. Original (tax) income distributions are tabulated by the IRS (2012) in constant income bins and these tables provide a basis for estimates of economic inequality in the USA.

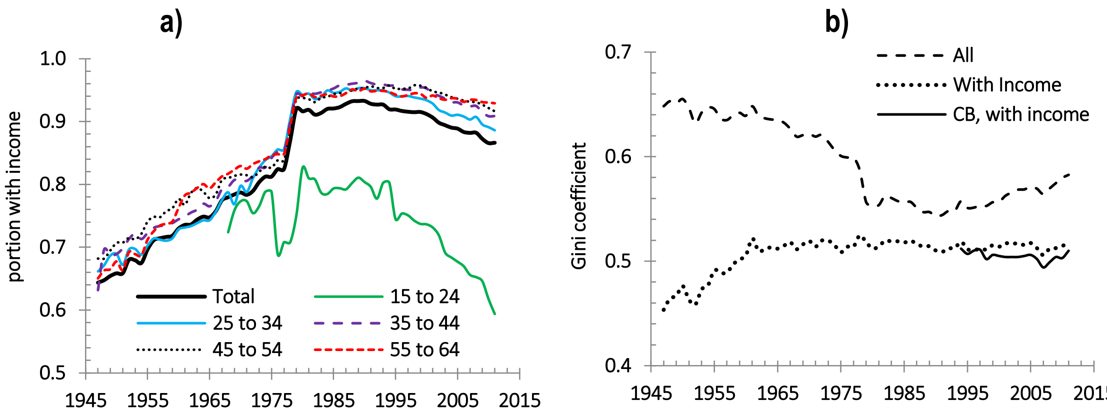

Figure 3. a) The overall and age-dependent proportions of working age population with income in the CPS.

Notice the 0.07 step between 1977 and 1978 caused by new income definition and steeper fall after 2003 – the year when new counting methodology was introduced. b) Three estimates of Gini obtained from the CPS data: “All” – for total population of working age including people without income, “With income” – for working age population reporting incomes in the CPS,”CB, with income” – the estimate reported by the Census Bureau.

Figure 4 compares income distributions for 1990 and 2011 as they are reported by the IRS. Since the income bins presented in the IRS tables are of increasing width one can observed some fluctuations in the distributions. These fluctuations are, obviously, related to those income bins, which are wider than their lower income neighbours. For example, the bin between \$25,000 and \$30,000 (width \$5,000) is followed by thebin between \$30,000 and \$40,000 (width \$10,000). Therefore, one can expect a larger number of people in the latter bin than in the former one. This effect is clearly observed in Figure 4, where the enumerated populations are assigned to the centres of corresponding income bins. We prefer to use the*log-log* scale in order to present highly changing population (and density) distributions in a very wide range of income, spanning seven orders of magnitude. The lowest income bin, corresponding to zero and negative (loss) reported incomes, is assigned to \$1 income. The bin with incomes above \$10,000,000 is not shown because of the absence of mean income estimate. One can easily derive an obvious conclusion from Figure 4 - there are more people with lower and high incomes in 2011 than in 1990. This is a mechanical result of increasing population – more and more people get income as the working age population is growing.

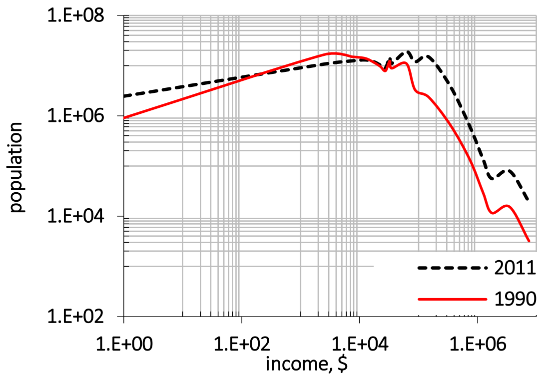

Figure 4. Comparison of(taxable) income distribution in 1990 and 2011, as reported by the IRS.

Note: Income bins increase in width. Enumerated populations are assigned to the centres of corresponding bins. Notice the*log-log* scale. The lowest income bin corresponds to zero and negative (loss) reported incomes, *i.e*. people without income. The bin with incomes above \$10,000,000 is not shown because of the absence of mean income estimate in this bin.

One should normalize the curves to the total population (with the IRS reported income) in given years in order to obtain population independent results. In addition to this normalization one can use population density instead of original population estimates in width-changing bins. When the measured populations are normalized to the corresponding income bin widths one obtains density of population as a function of income, i.e. the number of people per \$1 bin (for given year). As before, we assign the obtained population densities to the centres of corresponding bins. Figure 5a depicts two population density curves obtained after the normalization of the curves in Figure 4 to the total population with (IRS reported) income, which includes people without income and those with incomes above \$10,000,000, and to the respective widths of income bins. Both curves accurately follow the Pareto law at higher incomes.

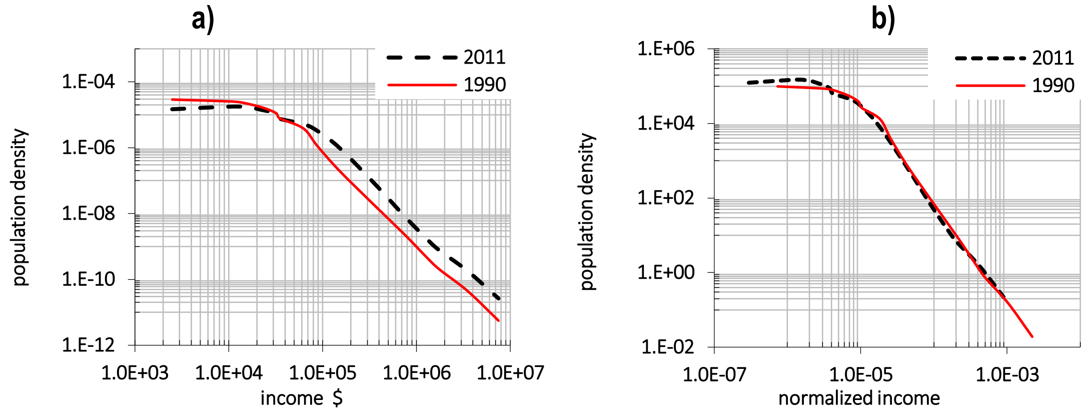

Figure 5. a) The curves in Figure 4 are normalized to the total population with income reported to the IRS and to the widths of corresponding income bins.

Note: Resulting population density distributions, *i.e.* the portion of people per $1-wide bin, are plotted as a function of income (central point of corresponding income bin). First (zero width) and the last (open-ended) income bins are not presented. b) The income scale in Figure 5a is normalized to the IRS total incomes, i.e. to $8.37+12 in 2011 and $3.41E+12 in 1990.

The total IRS personal income increased from $3.41E+12 in 1990 to $8.37+12 in 2011. The larger total income is a possible reason for the increased number of people with higher incomes. Two curves in Figure 5b represent those in Figure 4, which are normalized to the total personal income reported by the IRS. Income scales in 1990 and 2011 are also normalized to these total incomes and represent dimensionless portions of the total income. As a result, the width of a given income bin (say, between $5,000 and $10,000) in 1990 and 2011 becomes different since the relevant income scales are compressed by different factors. Also, the centres of the original income bins which were the same in 1990 and 2011 (see Figure 5a) are now shifted relative to each other by the factor equal the total incomes ratio. Figure 5b shows that the level of population density at lower incomes is higher in 2011, with the distributions in the Pareto range coinciding to the observed limit ($4,000,000 in 2011). There are several explanations of this observation. First, this is the results of some real (objective) processes of income redistribution between rich, middle class and poor people in the USA. This is a common opinion in economic literature. Because of the changes in the measured personal income distributions one needs some driving force explaining the process. Second reason for the changing distribution is not related to increasing income inequality but is associated with lower (and varying) accuracy of income measurements at lower incomes. The low-end of income distribution is open for uncontrolled variations which introduce a significant bias in inequality estimates.

The IRS covers smaller proportion of population and total personal income than the Census Bureau. Basically, the IRS reports some subset of income gainers relative to the Census Bureau. Therefore, the observed difference between economic inequality estimates based on IRS and Census Bureau data is likely results from lower reliability of the IRS estimate. Income reports for tax purposes cannot provide a consistent measure of personal income.

3. The household income inequality reported by the Census Bureau

When discussing the increase in income inequality, economists often forget those people who have no income at all. According to the Census Bureau, there are tens of millions reporting no income every year and this number has been really growing since 1990 as Figure 6a shows. As mentioned above, the dramatic fall in 1978 was caused by a larger revision to income definition. More than 15,000,000 were added to income gainers in a few seconds. The total population has been growing by approximately 1% per year. Figure 6b depicts the ratio of the number of people without income and the total working age population (15 years of age and over). This ratio has been growing since 1990 as well and there was no specific acceleration after 2007. It is not clear why these people are excluded by the

Census Bureau from the reported measure of income inequality in the U.S. Fortunately, they are included in the household-related inequality estimates.

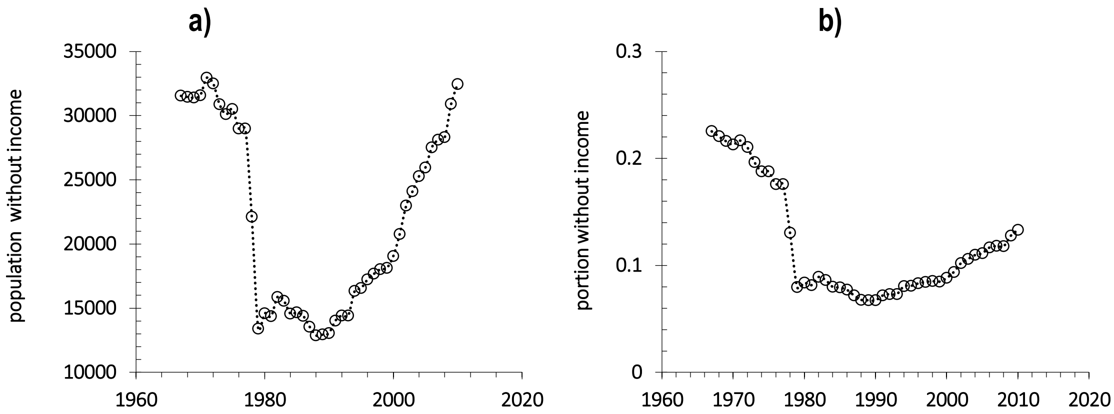

Figure 6. The number (a) and the portion (b) of people without income according to the Census Bureau's definition.

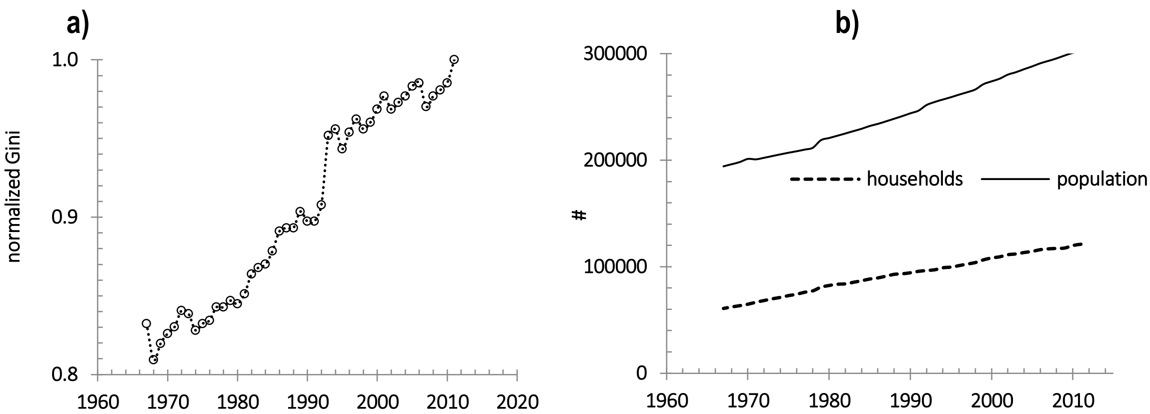

Figure 7. a) The evolution of normalized Gini coefficient for households.b)The evolution of total household population and the number of households (both in thousands)

In Figure 7a, we present the Gini coefficient for households. We intentionally normalized the ratio to its maximum value (0.477 in 2011) in order to show that this inequality measure has risen by 20% since 1967. This dramatic increase is interpreted as a big problem for the US but contradicts the observation of constant Gini coefficient for individuals. Unlike personal incomes, the household data are collected for entities which can evolve in size. Figure 7b presents the total household population and the number of households reported by the CB. From figure 7b one can obtain the evolution of the average household size, which is depicted in Figure 8a. Actually, the fall in the average size is quite spectacular: from 3.2 in 1967 to 2.49 in 2011.The simplest effect leading to the observed size decrease is household split - instead of one big household two smaller households appear. Obviously, the Gini coefficient depends on the distribution of household sizes. For fixed total income,the increasing number of households (split), which share the same amount of money, should result in a higher Gini coefficient. When all households are split to the smallest pieces (one person households) we have the personal income distribution with a larger Gini.

The observed fall in the average size indicates that one gets smaller households over time and the Gini coefficient should increase accordingly. The link between the average size and the Gini coefficient is not necessary a linear one. However, the simplest assumption of a linear relationship between the average size and Gini coefficient may give a conservative estimate of Gini coefficient for the observed fall in the average household size. Figure 8b shows the product of the Gini curve for households (Figure 7a) and the curve in Figure 8a. Now we see thetime history of Gini coefficientcorrected for the household size. This corrected Gini coefficientmight be not fully compensated for the changes in household sizes and income distribution but tells a different story: the Gini for households fell from 0.82 in 1967 to 0.72 in 1980, and then has not been changing. The step in 1993 is induced by the revision to income definition, i.e. this step is fully artificial. We consider the Gini coefficient for households as constant since 1980. This observation is consistent with constant Gini for personal incomes.

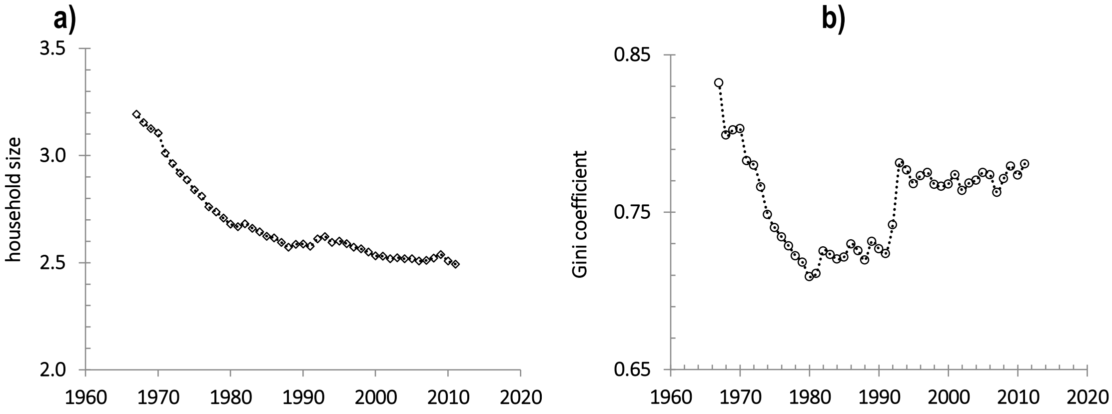

Figure 8. a) The evolution of an average household size.b) The household Gini coefficient corrected for the size of average household.

Overall, the Gini coefficient for households has not been changing as the CB estimate says because these estimates do not take into account the change in the household size distribution. This is a methodological error. The same logic must be applied to family income distribution –the CB's estimate is also biased. The mean and median income estimates are also affected by this mistaken procedure. Since the size of household has been decreasing the number of households has been growing faster than the total household population. The mean household income must also be corrected for the changing size. Figure 9a shows the actual evolution of the mean income (the evolution of median income is harder to recover).

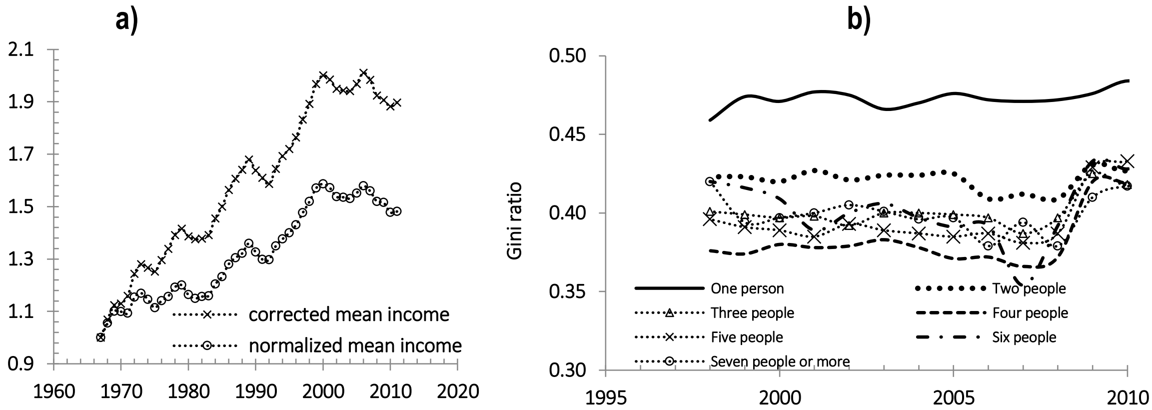

Figure 9. a) The growth of normalized (household) mean income and that corrected for the fall in the household average size.b) Gini coefficient for households of different sizes as reported by the Census Bureau.

The necessity of the household size correction is supported by the Census Bureau, which reports the Gini coefficient for households of fixed size. Figure 9b depicts these estimates, which demonstrate no change at all since 1993, except the one in 2009. (This step is induced by the introduction of new bins in the highest income end.) It is obvious that the change in the distribution of income among all households (e.g. the growth in the overall Gini coefficient) must be proportionally mapped into the growing Gini coefficient for all household sizes. Otherwise, the richest households should not have some prevailing size. Therefore, the absence of Gini growth in the households of given size proves the absence of the overall Gini coefficient change since 1993 (at least).

4. The Bureau of Economic Analysis

Thomas Piketty's book "*Capital in the Twenty-First Century*" (2014) attracts common attention and discusses the distribution of income between labour and capital. The deepest concern is related to the increasing share of capital income, which is also expressed in the growing portion of total income in the top 1% of families. Here we are showing that capital does not eat from the part of labour income but rather converts corporate income into the personal income. The source of increasing income inequality is in the tax law. At the end of the day, U.S. politicians are responsible for the increase in the portion of personal income for the richest families. There are no economic forces behind the change, which would be much more difficult to overcome.

The proportion of personal (money) income in the Gross Domestic Product has not been changing much since 1947. This is the year when the Bureau of Labor Statistics started to measure personal incomes. The source of some virtual increase in income inequality – private companies redistribute their income in favor of personal income of their owners. The question is – how do they get extra money to redistribute to their private owners? The U.S. tax system started to reduce the level of tax for private companies. Primarily, it wasmade by increase in the rate of depreciation which enterprises are officially permitted to charge for tax purposes (usually fixed by law).

We start with a graph showing the growth inGDP, gross personal income (GPI) measured by the BEA, and compensation of employees (paid) since 1929. Figure 10a demonstrates that the level of GPI has been rising faster than that of the GDP (and the compensation) since 1979. The share of GPI in the GDP has been rising since 1979 -the difference between the GPI and GDP curves depicted in Figure 10b has a striking kink around 1979. And this is the start of the rally in the rich families' personal income. In other words, a new political (taxation) era started in 1979. We would like to stress again that the proportion of the compensation of employees in the GDP has not been changing since 1929, with a small positive deviation in the end of 1990s and a negative deviation since 2009. This observation supports our previous finding that the proportion of personal (money) income in the GDP has not been changing.

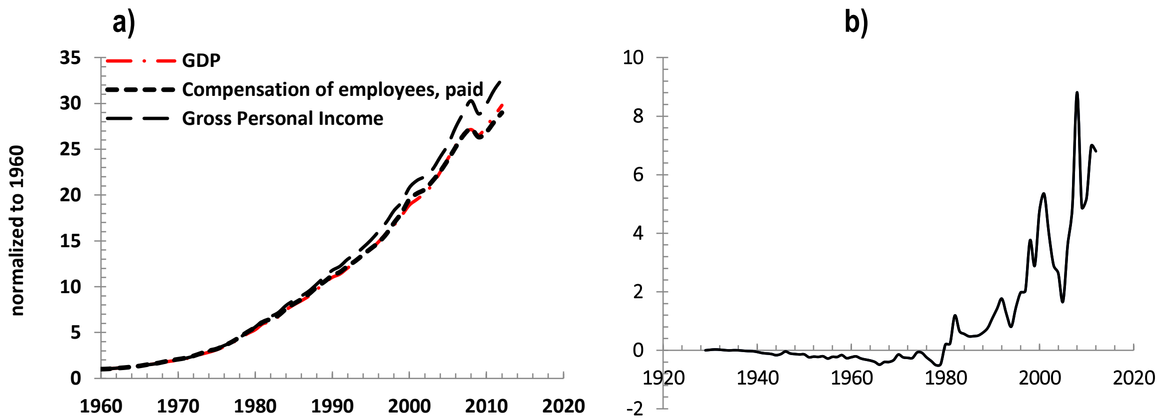

Figure 10. a) GDP, GPI, and compensation of employees normalized to their respective levels in 1960. b)The difference between the GPI and GDP curves.

Where the extra money is from? If the portion of personal income has been actually increasing in the GDP it should be a looser, which lost its share in the GDP. Figure 11a shows two major components of the GPI and the consumption of fixed capital. The net operating surplus (private) has been changing at the same rate as the GDP since 1929, while the proportion of taxes on production and imports has been growing at a lower rate since 1979. Finally, we have allocated the source of income for rich families. They take money from the decreasing taxes. But what is the mechanism of money appropriation? Figure 11a demonstrates that the decrease in taxes goes directly into the increasing share of consumption of fixed capital. This is the force behind the increasing income inequality. The increasing share of the consumption of fixed capital is successfully converted in private money, not in direct investments.

Piketty projects some further growth in the portion of capital income. Here we present an extremely simple observation which bans any further growth in the capital's share of income. Figure 11b displays the evolution of national income (NI), *i.e.* the sum of labour and capital income, and personal income (PI), both reported by the Bureau of Economic Analysis. In the 1940s, the difference between NI and PI was 15% and then stared to decrease. This is the period which Piketty highlights as the era of capital income, i.e. all increase in the share of personal income was appropriated by capital. However, no extrapolation of this tendency in the future is possible. Since 2011, there is no room for further growth in the share of capital income – the whole national income is distributed as personal income. There is no other source of income, except may be some decrease in the consumption of fixed capital (CFC). There is nothing to share any more.

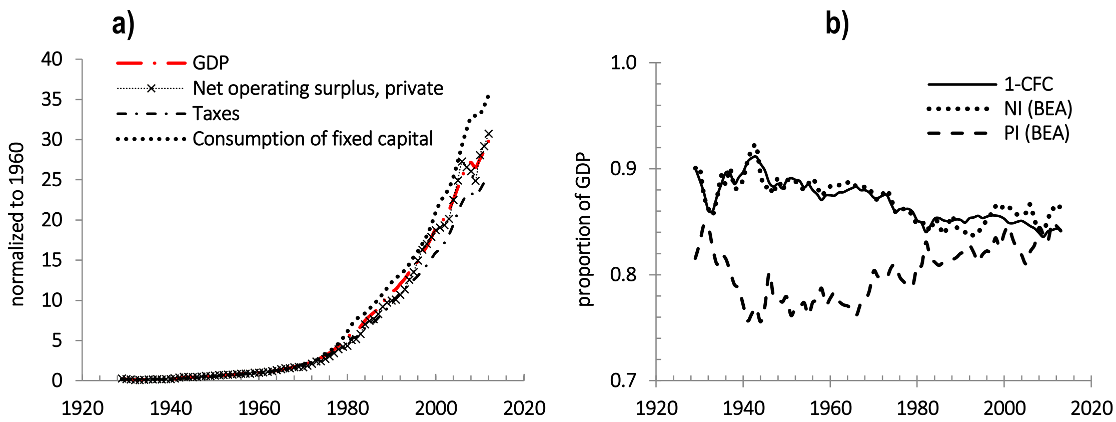

Figure 11. a) GDP, net operation surplus (private), and taxes (on production and imports), and consumption of fixed capital normalized to their respective levels in 1960. b) Evolution of national income (NI) and personal income (PI) both normalized to Gross Domestic Product. Currently, they are almost identical.

Conclusion

We conclude that the way three major U.S. agencies consider and resolve the problem of personal/household/family income and income inequality is counterproductive and confusing for quantitative analysis. The speculations about income inequality involve different and varying without control portions of the total income and population. Thus, these speculations are based on wrong qualitative assumptions because no of the involved quantities are compatible in definitions, measuring procedures, and over time (*e.g.*, CB, 2006). There is a specific aspect of inequality, which is full of intentionally biased numbers, however. The increasing inequality in incomes of household and families is directly misinterpreted.

The current estimates of income inequality based on data reported by the IRS are not reliable. The principal problem of the estimates is highly volatile incomes of people in the low-end of income distribution. This volatility is likely related to measurement errors, changes in definitions or improper reporting. At the same time, the IRS income estimates at high and the highest incomes are robust and follow the Pareto law. When normalized to total population with income and total (gross) personal income personal income distributions for 1990 and 2011 practically coincide. Hence, the inequality estimates based on the IRS data are distorted by readings in the low-income range.

The portions of labour and capital income in the total personal income reported by the BEA demonstrate secular changes. The portion of labour income in the GDP has not been changing much while the capital share increased significantly since the 1950s. The increasing share of income of the top 1% households does not affect the labour share income. The growth in the income share of richest families should be effectively stopped when the total personal income reaches the level of national income. This happened in 2011.

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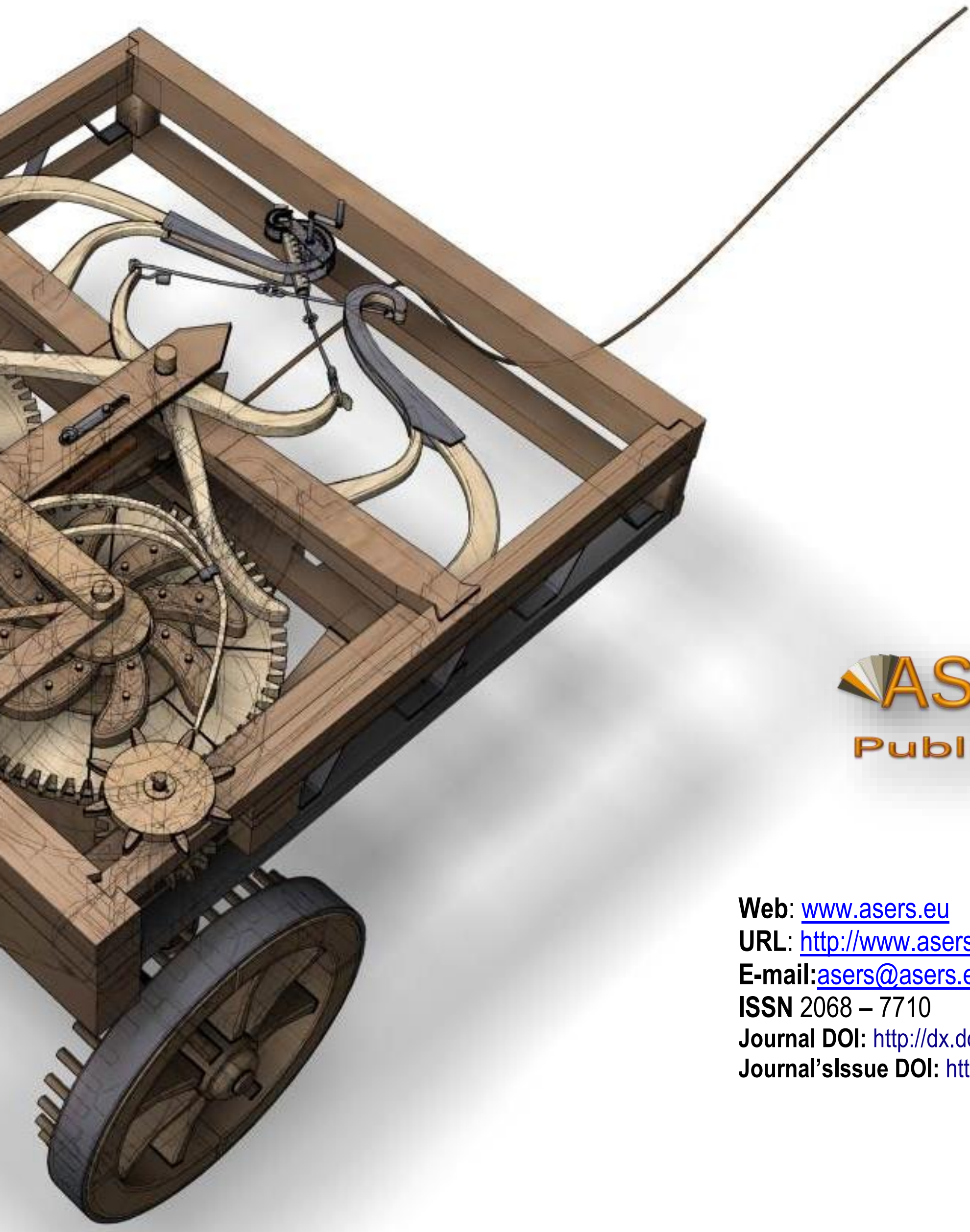

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