



Wealth Inequality Among the Forbes 400 and U.S. Households Overall*

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Introduction

While widening income inequality in the United States has garnered much public and academic attention in recent years, wealth inequality reveals an even starker picture.¹ For instance, in 2010, the top 1 percent of income earners received 19.8 percent of total household income. In the same year, the wealthiest 1 percent held 35.4 percent of total household wealth (Kaplan 2013). Moreover, wealth inequality has increased in recent decades, with most gains concentrated among the richest 20 percent of households (Wolff 2013).

Researchers have studied wealth distribution in terms of its mathematical properties as well as its trend, finding that wealth inequality has increased over the years (Keister 2000, Wolff 2013, Kaplan and Rauh 2013). Looking at the Forbes 400, Klass et al. (2005) point to a general trend of increasing wealth inequality from 1988 to 2003.

This report updates the empirical findings in Klass by extending the Forbes 400 data to 2012, and finds that the trend of increasing inequality among the wealthiest Americans still holds. This report also expands the study by exploring whether that distribution has any bearing on overall U.S. wealth distribution. To do so, other data and measures of inequality are employed to assess the characteristics and trends of wealth distribution. This report also notes the time correspondence of changes in wealth inequality and economic developments involving technology.

*The views expressed here are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Philadelphia or of the Federal Reserve System. When he wrote this report, Fuyuo Nagayama was a research analyst in the Research Department of the Philadelphia Fed. Questions and comments may be directed to Leonard Nakamura at Leonard.Nakamura@phil.frb.org.

¹ *Income* is defined as the flow of money received by the individual or household during a given period, typically reported as an annual figure. *Wealth* is defined as the value of an individual's or household's total assets net of the value of total liabilities. Total assets may include real assets such as houses and vehicles, and financial assets such as checking and savings accounts and stocks. Total liabilities may include mortgages, car loans, student loans, and credit card debt.

Data

The primary data sources used for this report are the Forbes 400 (1988-2012) and the SCF (1989, 1992, 1995, 1998, 2001, 2004, 2007, and 2010). The Forbes 400 is an annual list of the 400 individuals in the United States with the greatest net worth. Although the Forbes 400 represents the very top of the wealth distribution and therefore provides a very narrow base of comparison, there are advantages to studying this list. One, there are few sources of data on individual wealth outside the Forbes 400, and using individual data avoids the aggregation problems inherent in the standard approach to the study of wealth.² Two, the distribution of wealth in the Forbes 400 displays a striking statistical regularity, which can accurately be modeled by a Pareto, or power-law, distribution, as explored below. This regularity may provide insight into wealth distribution among a much wider range of people. In this report, the Forbes 400 data are inflation-adjusted to 2005 dollars using the personal consumption expenditures (PCE) chain-type price index.

The SCF is a triennial cross-sectional survey conducted by the Federal Reserve Board of balance sheets, income, and other demographic characteristics of U.S. households. For each SCF survey, about 4,500 to 6,500 households are interviewed. The survey includes a supplement in order to disproportionately select high-income households.³ Nonetheless, it is widely acknowledged that this oversampling is not sufficient to accurately capture the highly skewed nature of wealth distribution.⁴ Therefore, examining both the Forbes 400 and SCF gives a more balanced, comprehensive view. The SCF reports its results in 2010 dollars based on the “current methods” version of the consumer price index (CPI). To be consistent with the Forbes 400 data, we convert those SCF figures to nominal amounts, then inflation-adjust them to 2005 dollars using the PCE chain-type price index. Aggregate net wealth figures from the Federal Reserve Flow of Funds provide additional data on overall U.S. household wealth.⁵

² Aggregate values do not capture all the dimensions of the total of individual values. For example, one can know that the aggregate wealth of A and B is \$10 but not know whether A has \$1 and B has \$9, or whether A and B each have \$5, and so on.

³ The SCF includes a population-weights variable that is used in this study to estimate the population-wide standard deviation of real wealth so that the sample closely represents the population at large.

⁴ In particular, the SCF does not include individuals on the Forbes 400 list.

⁵ The Flow of Funds Accounts of the United States statistical release has been renamed the Financial Accounts of the United States to reflect its growing variety of data. See <http://www.federalreserve.gov/releases/z1/Current/z1r-1.pdf>.

Results

I. Pareto Distribution of Wealth and Its Trend Among the Forbes 400

Klass et al. (2005) show that wealth among individuals listed in the Forbes 400 from 1988 to 2003 is distributed according to a Pareto distribution.⁶ To extend the period examined to 2012, we first explore the fit of the Forbes 400 wealth distributions to Pareto distributions, as well as the value of the Pareto exponent, which quantifies the degree of inequality of the distribution over the years. We find a remarkable fit between the wealth distributions of the Forbes 400 and Pareto distributions. We also find an increasingly unequal distribution of wealth among the Forbes 400 from 1988 to 2012, measured by the value of alpha.

A Pareto distribution of wealth implies the following relationship between r (rank) and w (wealth):

$$w_r = Ar^{-\beta}$$

where w_r is the wealth of the r^{th} wealthiest person, r is the rank, A is a constant, and the exponent β is related to the Pareto exponent, α , as $\beta = \frac{1}{\alpha}$

Taking a log on both sides of the above equation, we obtain:

$$\log w_r = \log A - \beta \log r$$

On a log-log scale, this relationship implies that when wealth is plotted against rank, a linear relationship is observed, with slope $-\beta$. Conversely, in order to obtain the relationship for the Pareto exponent, α , transform the above equation to obtain:

$$\log r = \frac{1}{\beta} \log A - \frac{1}{\beta} \log w_r = \alpha \log A - \alpha \log w_r$$

A lower value of α (or a higher value β) implies a more unequal distribution of wealth.

A plot of real wealth versus rank in log-log scale in each year's Forbes 400 shows an excellent linear relationship, especially when excluding the nine wealthiest individuals from the plot. **Figure 1** shows the plot for 2012 (in red) and 1988 (in blue) side by side. Both plots are fitted very closely by a straight line ($R^2 > 0.99$). Importantly, the value of the slope in absolute terms increased from 0.612 to 0.831 (or the value of α from 1.63 to 1.20), implying a more unequal distribution of wealth among the Forbes 400 in 2012 than in 1988.

⁶ Recent studies (Clauset et al. 2007, Brzezinski 2013) have argued that data's good linear fit on a log-log scale indicates *only* that it is consistent with the power-law distribution, not that it is sufficient per se to establish the power-law distribution. They have also raised concerns that the estimate of the Pareto exponent (α) by a slope of the regression line on a log-log plot may be biased. Newman (2009) suggests an alternative method for extracting the Pareto exponent:

$\alpha = 1 + n \left[\sum_{i=1}^n \ln \frac{w_i}{w_{min}} \right]^{-1}$ where n is the number of observations, w_i are the individual values of wealth, and w_{min} is the smallest value of wealth for which the power-law behavior holds. It is beyond the scope of this report to carry out rigorous statistical tests to confirm the power-law distribution.

Figure 2 brings back the nine wealthiest individuals. The fit is still excellent, at R^2 above 0.98. In constant 2005 dollars, the wealth of the wealthiest American increased by 450 percent, from \$10.3 billion to \$56.7 billion; that of the 20th wealthiest American by 363 percent, from \$2.8 billion to \$13 billion; and that of the 400th wealthiest American by 125 percent, from \$400 million to \$900 million. Even in proportional terms, the unequal gains are telling of the extent of the unequal wealth distribution captured by the Pareto exponent α .

Figure 3 plots the evolution of the value of α from 1988 to 2012, in the range $10 \leq r \leq 400$. The overall trend in the value of α , which is the inverse of the slope of the straight line, declined from 1988 to 2012, indicating an increasingly unequal distribution of wealth. The value of α declined most rapidly during the technology bubble of the late 1990s, reaching its lowest point in 2000, coinciding with the peak of the bubble. The value of alpha started to increase after 2000, but then began to decline again around 2005.

Figure 1: Forbes 400 Rank vs. Real Wealth in Log-Log Scale, Excluding the Nine Wealthiest.

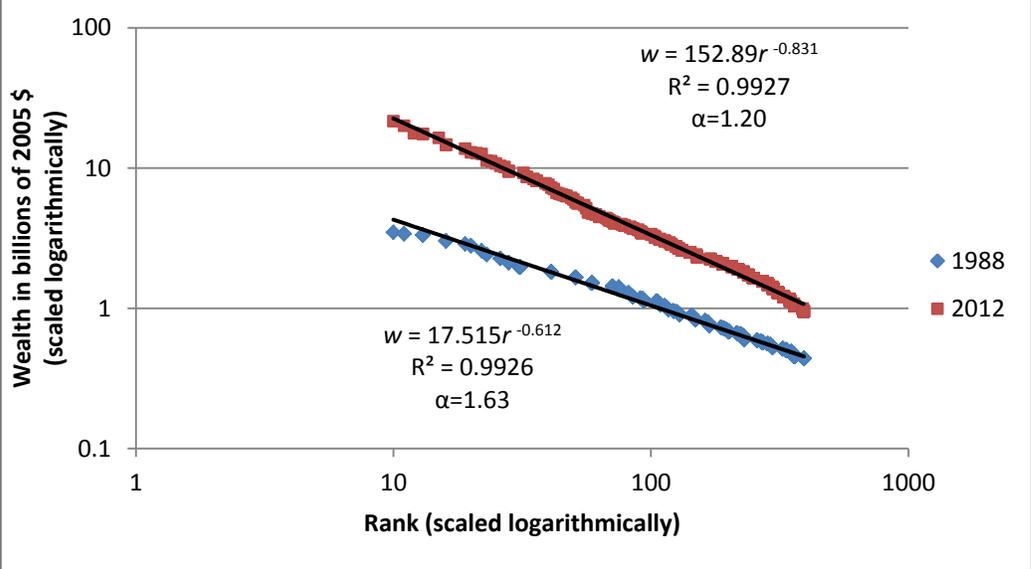


Figure 2: Forbes 400 Rank vs. Real Wealth in Log-Log Scale, Including the Nine Wealthiest.

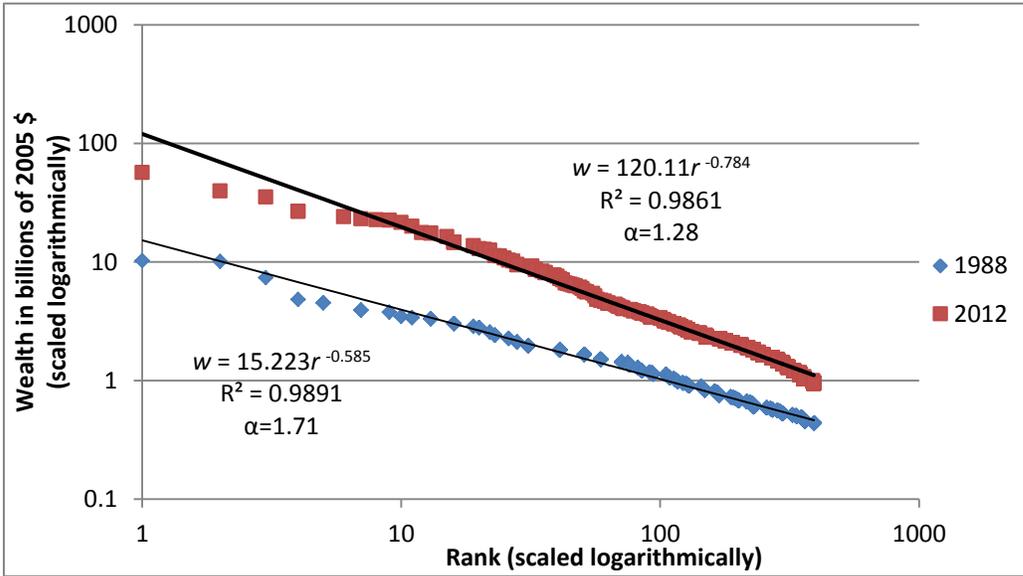
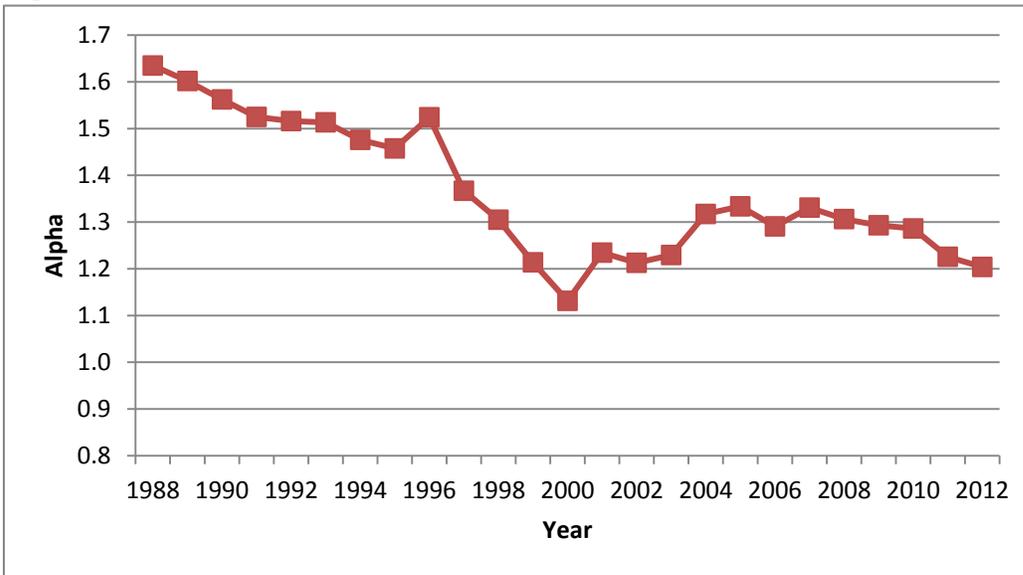


Figure 3: Forbes 400 Time Series of α , 1988-2012.

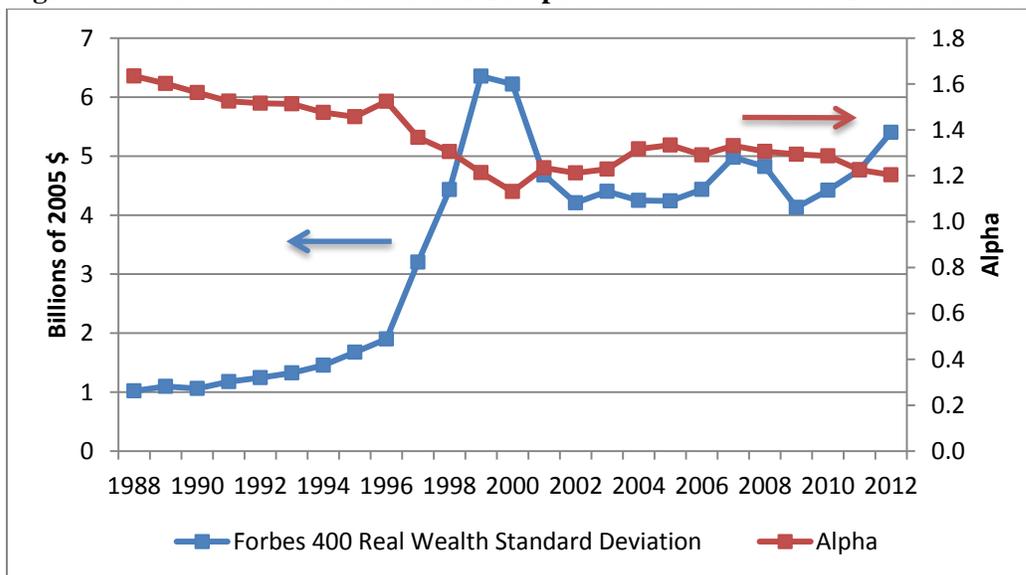


II. Relationship between α and the Standard Deviation

The Pareto exponent is an appropriate measure of inequality at the upper end of the wealth distribution, such as the Forbes 400, because that segment follows a Pareto distribution. However, most wealth distributions, such as in the SCF, seem to follow log-normal or gamma distributions, for which the Pareto exponent is not an appropriate measure of inequality (Brzezinski 2013). Therefore, we now turn to the standard deviation to measure inequality.⁷ Although the standard deviation is not a perfect measure of inequality for these distributions, it provides a general, readily obtainable picture.

To study the relationship between α and the standard deviation as a measure of inequality, we look at the standard deviation of wealth within the Forbes 400. We find a highly negative correlation, with a correlation coefficient of -0.95. **Figure 4** plots α against the standard deviation of real wealth from 1988 to 2012. The opposite movement of the two series is readily visible. Moreover, the year of the highest standard deviation (1999) corresponds closely to the year of the lowest alpha (2000), which is around the height of the technology bubble.

Figure 4: Forbes 400 Time Series of α Compared with Real Wealth Standard Deviation, 1988-2012.

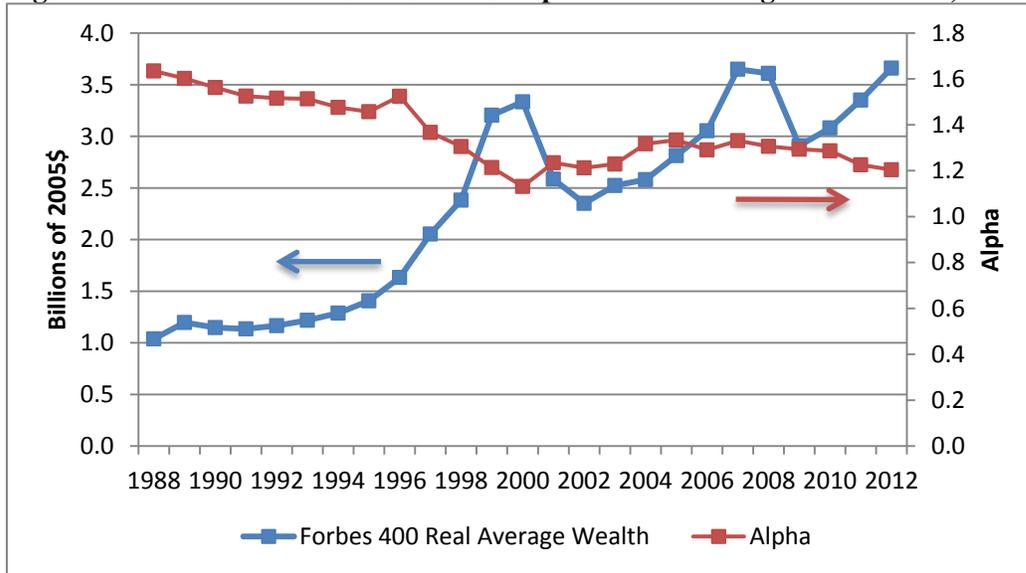


⁷ Standard deviation is a measure of how far a set of numbers is spread out. It is mathematically defined as the square root of the average of the squared differences from the mean.

III. Average Wealth and Wealth Inequality

As suggested by Klass (2005), variations in average wealth over the years may help explain fluctuations in inequality. We look at the relationship between α and average real wealth in the Forbes 400 and find a highly negative correlation (a correlation coefficient of -0.87) from 1988 to 2012. As seen in **Figure 5**, the average real wealth series reflects the technology bubble of the late 1990s (the most rapid increase in average wealth), as well as its aftermath in the early 2000s (the sharpest decline in average wealth). A temporary peak in average real wealth (2000) corresponds with the year with the lowest alpha (2000), at the peak of the technology bubble.

Figure 5: Forbes 400 Time Series of α Compared with Average Real Wealth, 1988-2012.

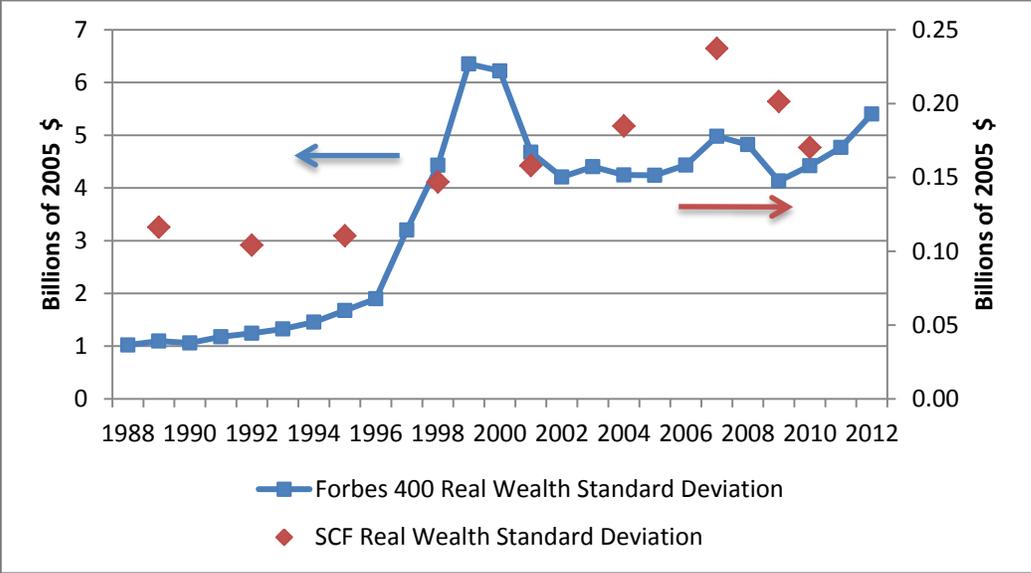


IV. Forbes 400 and Overall Wealth: Comparison with the SCF

We now look at the SCF data to examine the relationship between the standard deviation of real wealth in the Forbes 400 and in U.S. households at large. We find a relatively high correlation between the two series, with a correlation coefficient of 0.83. This correlation suggests that the time trend of the degree of wealth inequality of the Forbes 400 has at least some bearing on overall wealth inequality. But as seen in **Figure 6**, there are notable differences between the two series. The Forbes 400 real wealth standard deviation series has two local maximums, corresponding with the peaks of the technology bubble in 2000 and the housing bubble in 2007. The SCF real wealth standard deviation series has only one peak, in 2007. This difference suggests that, unlike for the Forbes 400, overall U.S. household wealth was affected much more significantly by the housing bubble than by the technology bubble. This disparity is reasonable, because the wealth of most households consists primarily of home equity. After reaching a local minimum in 2009, the standard deviation in wealth in the Forbes 400

continuously increased from 2009 to 2012. By contrast, the standard deviation in wealth for U.S. households surveyed in the SCF continuously declined from 2008 to 2010.

Figure 6: Comparison of Real Wealth Standard Deviation in the Forbes 400 and SCF.



V. Forbes 400 and Overall Wealth: Comparison with the Flow of Funds

Finally, we look at the relationship between the total wealth of the Forbes 400 and the wealth of all households and nonprofit organizations (NPOs) as reported in the Federal Reserve Flow of Funds. Because the Federal Reserve figures are in nominal terms, we inflation-adjust them to 2005 dollars using the PCE chain-type price index for consistency. As seen in **Figure 7**, the movement over time in the total real wealth of the Forbes 400 largely paralleled that of all households and NPOs. This relationship is another indication that the Forbes 400 wealth distribution has some bearing on overall household wealth distribution.

Figure 7: Forbes 400 Wealth Compared with Household & NPO Wealth, 1988-2012.

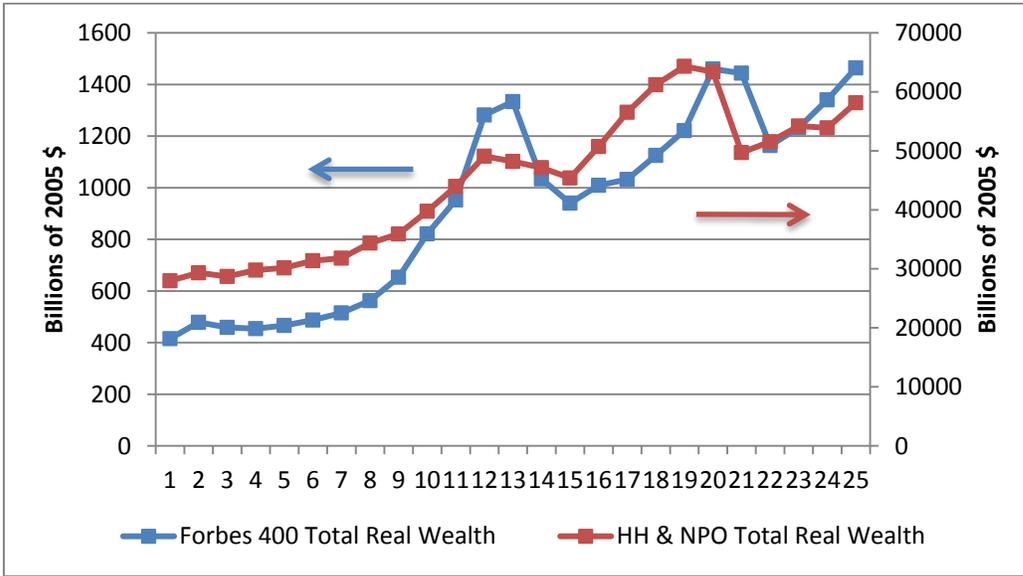
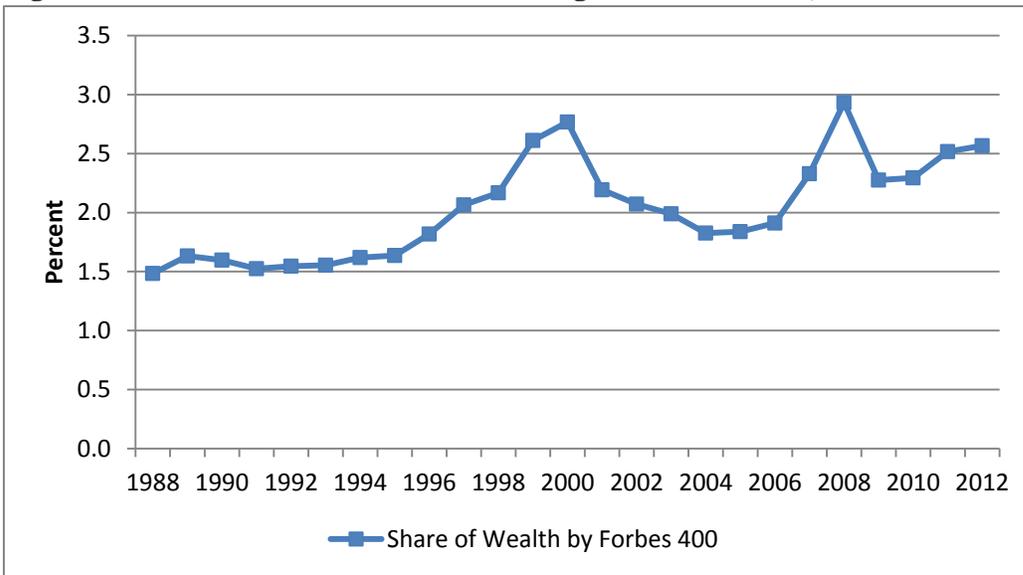


Figure 8 shows the time series of the share of real wealth held by the Forbes 400 as a percentage of total real wealth held by all U.S. households and NPOs. The share of wealth accruing to the Forbes 400 has had an overall upward trend, increasing from 1.5 percent in 1988 to 2.6 percent in 2012 (peaking at 2.9 percent in 2008). This result is consistent with the literature on wealth distribution, which suggests that the gains in wealth in recent years have been concentrated among the richest Americans.

Figure 8: Share of Total Real Wealth Accruing to the Forbes 400, 1988-2012.



Discussion

Updating the findings of Klass et al. on wealth distribution, this report shows that inequality has continued to widen among the Forbes 400. This report also extended the examination of wealth distribution to U.S. households overall, finding that there is a substantial correlation between the trend of wealth distribution among the wealthiest individuals and among U.S. households overall. This report does not explore the causes of the trend. However, the empirical results show a correspondence between the technology bubble of the late 1990s and wealth inequality, especially among the Forbes 400. It may be noted that the trend of increasing wealth inequality established in earlier studies and confirmed in this report has coincided with the rise of technology and technology-based businesses in the economy in recent decades. Studies have suggested that there is an intimate connection between the technological, knowledge-based economy and growing economic inequality (Goldin and Katz 2010). Kaplan and Rauh (2013) find that the share of the Forbes 400 engaged in technology businesses or businesses with a significant technology component increased from 7.3 percent in 1982 to 25.5 percent in 2011. This explanation for the trend of widening wealth inequality complements those offered by Atkinson, Piketty and Saez (2011), who suggest that tax policy and the structure of labor markets likely had an impact as well. Much research remains to be done to understand the causes driving the properties and time trend of wealth distribution identified in this report.

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