Inflation heterogeneity and its impact on inequality: evidence from the United States

Tavares, Francisco

4 January 2021

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January 2021

Abstract

Aggregate inflation measures such as the Consumer Price Index seek to capture the impact on households consumption possibilities of changes in prices over time and are generally assumed as representative of all consumers. This is only true if households have all the same consumption patterns. Based on household level microdata, we construct specific household baskets of consumption and calculate the inflation for each one. By comparing Plutocratic and Democratic indexes, and inflation between groups of income, we conclude that households experienced different inflation rates, with the poorer suffering more with the loss in the purchasing power. The potential impacts of these findings on Fiscal and Monetary Policy show that around 1.77 million households could be paying federal income taxes when they should not; Social Security benefits could be up to 9.70% higher for some households; Federal Funds Rates would be 0.8 percentage points higher, based on a Taylor type rule, if FED used a Democratic core inflation index.

Keywords: Inflation, Consumer Price Index (CPI), Price Indexes, Personal Consumption Expenditure Price Index (PCE), Consumption Patterns, Consumer Expenditure Survey

JEL Classification: E20, E31, E43, E52, E62, G50

1 Introduction

Aggregate inflation measures try to capture the impacts that systematic changes in prices have on consumption possibilities of households. The Consumer Price Index (CPI) is one of the most important aggregate measures and a base for changes in the cost-of-living in the United Sates.[1] The CPI measures the changing costs in a wide range of goods and services purchased by the "representative" American household. Moreover, it is used in several different circumstances, from income taxes indexation to interest rates, being a crucial tool of the American economic system.

Due to its measurement complexity, CPI has been a topic of discussion and widely studied over the years. In 1996, the "Boskin Commission", formally denominated "Advisory Commission to Study the Consumer Price Index", was appointed by the United States Senate in order to infer CPI and advise the Bureau of Labor Statistics (BLS) on how to improve and more accurately estimate the CPI. The report, Boskin (1996), pointed several issues that were leading to an overestimation of the CPI in about 1.1 percentage points (pp) in 1996. This conclusion was very relevant given that Social Security contributions and Federal Income Taxes were indexed to CPI, having this bias a direct impact on the budget deficit. Diverse problems were identified, being a major one the lack of updates of the base period years, and in the weights and goods included in the CPI basket. This lack of changes was causing a significant substitution bias in the CPI, which had been already mentioned by Alan Greenspan, the Federal Reserve System (FED) chairman at the time, and was one of the reasons that led the FED to start following the Personal Consumer Expenditure Index instead of the Consumer Price Index, in 2000. Other referred problems were the quality change bias, given that quality improvements in goods was not internalized, and also the application of a Laspeyres index, which tends to overestimate the "true" index, instead of other methods, just like a Fisher Ideal Index (the geometric mean of Laspeyres and Paasche indexes).[2]

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[1]When mentioning CPI we refer to the most common and used index which the Consumer Price Index For All Urban Consumers (CPI-U)

[2]Boskin et al. (1998) provide a readily accessible and self-contained discussion of the issues involving CPI

Since 1996, the Bureau of Labor Statistics implemented significant changes in the CPI and its formulation. The most important one was a more regular update of the basket of goods and weights. Currently, the BLS changes the basket every two years (2018 CPI basket is based on the Consumer Expenditure Survey of 2015 and 2016); while between 1940 and 2000 the basket was updated only 5 times. Despite the changes and improvements, CPI is still a very present discussion, as studies try to understand the representativeness of this one.

The belief that CPI represents all American households is countered by the fact that households have different consumption patterns and, consequently, each one weights the goods in their basket of consumption differently. As such, if the basket is not equal to CPI's one, then the inflation rate experienced by certain households might not correspond to the published one. Many investigations try to infer the validity of this argument and compare households' specific inflation rates with the CPI, most of them concluding that there is heterogeneity in inflation rates among households.[3] A common suggested alternative to the CPI formulation is a Democratic inflation index. Under this procedure, every household contributes the same to the final CPI, contrary to the current Plutocratic procedures where each household's contribution is proportional to its total expenditures. Thus, CPI provides values where richer households have a higher weight, creating a bias towards the inflation experienced by richer groups.

Question arises on whether it is possible to aggregate households via certain characteristics which lead to similar consumption patterns within them. According to several studies and authors, it is assumed that poor households spend more of their income in basic need goods, than richer households, which creates different baskets and can, thus, deliver distinct inflation rates between these income groups.[4] By neglecting this issue, inequality estimations will not be accurate and society might be facing a larger dispersion on consumption possibilities than the estimated one.

Federal income taxes and Social Security funds, among other state mechanisms, are in-

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and the Boskin (1996).

[3]See Section 2: Literature Review

[4]Leicester et al. (2008), Arrow (1958) and Garner et al. (1996)

dexed to CPI to compensate for the increases in the costs-of-living. Every year, funds and tax brackets increase or decrease according to inflation. However, if CPI does not fully represent the inflation experienced by certain households, then these households will not be fully compensated by the increase in their cost-of-living, a concern expressed by Hagemann (1982).

Concerning monetary policy, the FED in August of 2020 updated its Statement on Longer-Run Goals and Monetary Policy Strategy. It now includes a more inclusive definition of the employment mandate which is expected to bring more benefits to minority groups and low-income communities.[5] Having this in mind, we ask if FED should not be following a Democratic inflation index in detriment of the current Plutocratic one, given that the first gives the same importance to all households, hence it will deliver a more accurate estimate of the inflation experienced by low-income groups.

Our study addresses all the issues and questions mentioned. Supported by Consumer Expenditure Survey micro data, we construct baskets of consumption for each household and estimate the correspondent specific inflation rates. Using the survey of the respective year to formulate the baskets, we minimize the substitution bias and are able to compare our inflation rates with the published CPI. Moreover, we explore the representativeness problem, by constructing Democratic inflation rates and studying the dispersion among households. Further in our analysis, we construct specific inflation rates for groups of income and other common characteristics and compare them overtime. Finally, we apply these conclusions to policy implications through the indexation of tax deductions, social security benefits and apply Democratic indexes to the conduction of monetary policy. We contribute to the existent literature and research not only by applying previous procedures to a more recent time period, but also by studying policy implications when policies are designed taking into account inflation heterogeneity across households. The study includes quarterly data from 1994 to 2018, amounting to a total of 100 periods analysed. During this period, we conclude that households in decile 2 (the decile with higher inflation over time) experienced yearly inflation rates 0.24 percentage points higher than

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[5]see: https://www.federalreserve.gov/monetarypolicy/review-of-monetary-policy-strategy-tools-and-communications-statement-on-longer-run-goals-monetary-policy-strategy.htm

households in decile 10 (the ones with lower inflation over time). When computing the Net Present Value (NPV) for the inter-temporal purchasing power, we conclude that decile 10 had a NPV 2.33% higher than decile 2 and the Top 1% of income a NPV 2.6% higher than the bottom 90% of income. Furthermore, we estimate that, in 2017, around 1.77 million households could be paying federal income taxes when they should not, due to an under indexation of income tax deductions. In terms of Social Security benefits, if funds and pensions were updated based on each group specific inflation, households in decile 2 would receive benefits 9.7% higher than the actual ones and households with elderly cohorts 6.68% higher, in 2018. Finally, when applying our conclusion to monetary policy we state that, based on a Taylor type rule, Federal Funds Rate could be 0.8 percentage points higher, on average, if FED followed a Democratic Inflation Index.

The paper proceeds as follows: Section 2 briefly reviews literature on inflation measurements and specific-group inflation rates; Section 3 describes the data and methodology used for our estimations; Section 4 presents our results; Section 5 explores the policy implications; Section 6 concludes.

2 Literature Review

Inflation representativeness and its heterogeneous impact on different groups of the society has been a matter of study over the last decades. In the United States, Arrow (1958) and Snyder (1961) were the first authors to present studies on this issue. Arrow (1958) noted that people with low income have different spending patterns than high income groups as they spend a larger share of their income on basic needs. Snyder (1961) produced experimental indices for low and high-income groups concluding that, during recessions, the price of inferior commodities and other commodities of greater importance to low-income groups decreased more slowly than commodities associated to middle and high-income groups. During inflationary periods, inferior commodities tended to increase faster than the rest.

Using the American Consumer Expenditure Survey, Michael (1975) and Hagemann (1982) were the first to infer on inflation representativeness. Both studies conclude that there are significant differences between groups, although Michael (1975) argues that changes are not persistent over time. Moreover, Hagemann (1982) study is particularly relevant because it was published after the Economic Recovery Tax Act of 1981, in which income taxes and tax brackets were indexed to CPI. Following this, the author analysis also concerns possible heterogeneous inflation impacts through taxes. In other study, Garner et al. (1996) produced specific low-income price indices and compared it with the whole population between 1984 and 1994. They found no significant differences between the two indices.

Hobijn & Lagakos (2005) measure the degree of inequality in inflation across U.S. households for the period between 1987 and 2001. They found that distribution of inflation experiences across households exhibited a large amount of dispersion over the entire sample period. Cost of living increases were generally higher for the elderly and the fluctuations in gasoline prices impacted poor households more significantly. They also conclude that households that experienced high inflation in one year did not generally face high inflation in the following one. Hobijn et al. (2009) present a more complete study, analysing price indices between 1984 and 2004. They state that the distribution of inflation experiences across households exhibits a large amount of dispersion over the entire sample period. Moreover, democratic mean was persistently higher than the plutocratic mean during the last observed years, with poorer households experiencing higher inflations than richer households, due to high gas and food prices over those years.

More recently, Argente et al. (2018) and Jaravel (2019) made use of detailed barcode-level scanner data in the US retail sector, provided by Nielsen, to study price divergences between households. Argente et al. (2018) constructed income-group specific price indices for the period from 2004 to 2010 and found significant differences during the Great Recession, with the highest quartile experiencing prices 0.7pp lower than the bottom quartile. They explain this difference by the way consumers adjusted their shopping behaviour to mitigate the crisis. Jaravel

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(2019) concludes that, between 2004 and 2015, higher-income households are found to systematically experience a larger increase in product variety and a lower inflation rate for continuing products. This product variety delivers more competition to this section of the market, allowing higher-income households to experience lower inflation rates.

In studies concerning other countries than the United States, Crawford & Oldfield (2002) examined whether the inflation rate in the United Kingdom is representative for all households. The authors concluded that, on average, over the period from 1976 to 2000, only about a third of households at a point in time faced inflation rates within 1 percentage point of the average rate. Moreover, the representativeness of the average rate tends to be lower when inflation is high. Not taking into account differential inflation can lead to misleading conclusions about the growth in inequality from one year to the following, over or understating it by as much as 6pp. Leicester et al. (2008) produce a similar study in the UK, focusing on the elderly and pensioners, which experienced a significantly higher inflation than non-pensioners in the last observed years.

In South Africa, Oosthuizen (2007) states that, between 1998 and 2006, neither the poor nor the rich faced consistently higher inflation rates. Income groups face different inflation rates in each year, however differences are not significant when looking at the whole period. Sugema et al. (2010) show that, in Indonesia, poor had a significantly different inflation than the rest of the population, between 2006 and 2009. Concerning Spain, Izquierdo et al. (2003) conclude that the plutocratic gap from 1992 to 1997 was, on average, positive, which means that the plutocratic index was higher than the democratic one, but the difference was not significant. Lastly, Lieu et al. (2004) apply this study to Taiwan and were able to conclude that different household groups face differential price changes. The poorest group faced a significantly higher inflation rate than the rest of the population, amounting to 0.15pp annually.

Overall, all studies tend to confirm that consumption patterns differ significantly between households. These differences impact the inflation that each one suffers, leading to a large dispersion of price indices. Despite this, there is no consensus on the persistence over time of

larger price indices for some groups, with only some studies concluding that poorer households experienced consistent higher inflation rates.

3 Data and Methodology

3.1 Consumer Expenditure Survey

During our analysis, we use the Consumer Expenditure Survey (CES), published by the BLS, to analyse households' expenditure patterns and construct household specific baskets of consumption. The CES is the only federal government survey that provides information on the complete range of consumers' expenditures as well as their incomes and demographic characteristics. Results of the CES are used to define the weights of goods and services for the Consumer Price Index, to determine the relative importance of components, and to derive cost weights for the market baskets. This is a continuous survey that includes around 10 thousand households. Each household reports during 4 consecutive quarters of the year, answering to 5 interviews before exiting the survey (the first interview collects demographic and family data only). Given this, every quarter, 20% of the survey is composed by new respondents.

The CES includes two different surveys, a Quarterly Interview Survey and a Weekly Diary Survey. In the Interview survey, a household reports his expenditures during the previous 3 months. This survey is designed to collect data on major items of expense, which respondents can be expected to recall for 3 months or longer. This survey collects detailed data on around 60 to 70 percent of all household expenditures. Adding to these, are the global estimations for other goods, typically purchased on a daily basis like food, which tend to represent 20 to 25 percent of total expenditures. Overall, the survey is able to estimate around 95% of households total expenditures. In the Weekly Diary Survey, households record all their expenditures during two weeks. This last survey is more precise for small purchases, but does not include as many expenditures as the Interview Survey. Not being able to combine both surveys, because households do not answer to both surveys, we only use the Quarterly Interview Surveys between 1994

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and 2018, because it is the one that provides a more complete scenario.

There are specifications regarding CES that are worth mentioning. Firstly, we define household as our consumer unit (CU). A consumer unit, according to the BLS, is defined as: all members of a particular household who are related by blood, marriage, adoption, or other legal arrangements; a person living alone or sharing a household with others or living as a roomer in a private home or lodging house or in permanent living quarters in a hotel or motel, but who is financially independent; or two or more persons living together who use their income to make joint expenditure decisions.[6] In the survey, each household has a unique identifier code, which allows to identify the household between surveys. Moreover, CES allows to weigh each household in order to correspond to a certain number of households in real terms. On average, each household represents 10 thousand real households. With this weighting possibility, we are able to estimate for the whole American household population.

Secondly, Interview Surveys are reported quarterly, including expenditures from the 3 previous months. As it is a continuous survey, households can be interviewed in any time of the year. An issue arises, because, for example, in the Interview from the first quarter of 2018, there will be households that answered to the survey in January, meaning that they only reported expenditures from 2017. In order to overcome this problem, relative importances must be attributed to each household, depending on the month of the interview. A household reporting in January 2018 will not contribute for 2018 estimations and the ones answering in February, will only contribute with one-third of their expenditures. To guarantee consistency in our estimations, we attributed weights to each household depending on the month of the interview. Lastly, from the 10 thousand households that, on average, answer to the survey each quarter, we delete the ones that present negative income, negative expenditures or omitted answers, because by definition these variable can not be negative. As this may correspond to measurement errors, by retrieving these observations, we believe that we can achieve more accurate and precise estimates.

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[6]see: https://www.bls.gov/cex/csxgloss.htm

3.2 Price Indexes

As CES reports quarterly surveys, we collected quarterly, not seasonally adjusted, price indexes from the Consumer Price Index for each good, between 1994 and 2018. Moreover, our series present the growth rate in prices from one quarter to the same quarter of the next year.

There is no perfect match between the goods in CES and in the CPI, given that some goods and services are collected with different methodologies. In order to obtain the closest and more accurate match, we aggregated all goods in 17 different groups (*m=17*). These groups are: Food at Home, Food Away from Home, Alcoholic Beverages, Shelter, Utilities, Household, Apparel, Vehicles, Gasoline, Other Vehicles Expenses, Public Transportation, Health Care, Entertainment, Personal Care, Telephone Services, Education and Tobacco. Table 2 presents the match between the CES and CPI, the correspondent groups and a brief explanation of each one. Our results depend on the level of aggregation and precision of our groups. With these 17 categories, we will study the differences between groups of goods, but will not be able to account for within group differences, as discussed by Hobijn & Lagakos (2005).

3.3 Methodology

With the detailed information on expenditures provided by the Consumer Expenditure Survey, we construct specific household inflation rates. We calculate the relative importance of each group of goods in total expenditures of each household. Then, we apply the group's inflation rate published by the CPI. The sum of all the relative importances will be 1, representing all expenditures incurred by the household. Contrary to the CPI, we will not use a Laspeyres price index, which uses the quantities of the base period. Equation 1 shows the formula, where *t* is the time period, *b* is the base period, *j* represents a group of goods and *m* is equal to 17, the total number of groups. $w_{j,b}$ represents the weight of group *j* in the basket, in the base period *b*.

$$\pi_t^{CPI} = \frac{\sum_{j=1}^{m} w_{j,b} \frac{P_{j,t}}{P_{j,b}}}{\sum_{j=1}^{m} w_{j,b} \frac{P_{j,t-4}}{P_{j,b}}} - 1 \tag{1}$$

Despite being easier to produce in practical terms, given that information regarding quantities is not always available for the current period, this index may create a substitution bias, given that it does not account for the changes in preferences and goods consumed due to increases in prices. In order to minimize this bias, we update every base period and with that the correspondent quantities and weights. Similarly to Hobijn & Lagakos (2005), our household specific inflation rate is represented by:

$$\pi_t^H = \sum_{j=1}^m w_{j,t} \pi_{j,t} \tag{2}$$

Where $\pi_{j,t}$ is the inflation rate of group j in time t for household H. Moreover $\sum_{j=1}^m w_{j,t} = 1$, guarantees that the sum of groups' expenditures is equal to total expenditures. Our data does not have the precise information on the price each household faces. We know that the same good can have different prices, depending on location or time of the day. Thus, we rely on literature and assume that all households face the same price for the same good.

4 Empirical Analysis

4.1 Plutocratic Inflation vs Democratic Inflation

The Consumer Price Index, just like other common price indexes, is a Plutocratic measure. In this conventional way of calculating expenditure weights, the importance of each household in the final index is based on its expenditures. Mathematically, this weighted expenditure mean is represented by:

$$P_{x,i,t} = \frac{\sum_{i=1}^n E_{x,i,t-4} \frac{P_{i,t}}{P_{i,t-4}}}{\sum_{i=1}^n E_{x,i,t-4}} - 1 \tag{3}$$

$E_{x,i,t}$ is expenditure of group x (in this case the whole population) for the good i in period t, $P_{i,t}$ is the price of a good i in period t consumed by the whole population. *t-4* represents the previous time period, in this case the correspondent quarter from the previous year, because we

are working with quarterly 12-month changes. Based on this procedure, richer households are expected to have a larger importance on the final index, due to the fact that they consume larger quantities than poorer households. Furthermore, this index is easier to calculate because it does not require to obtain households' specific inflation rates.

An alternative way of calculating a price index is through a Democratic index, which is an arithmetic mean of households' inflation rates, thus so the population mean inflation. Each household contributes with the same importance to the final index. Mathematically, this index is represented by:

$$D_{x,i} = \frac{\sum_{i=1}^{n} \pi_{h,i}}{n} \tag{4}$$

Where $\pi_{h,i}$ is the price faced by household h and n is the number of total households.

Both measures are assumed to be correct for economic procedures. However, they tend to provide different values. The intuition behind the difference is that if we assume two households, one spending \$60 and the other \$40, then based on the Plutocratic, the first will correspond to 60% of the final index and the second 40%, while in the Democratic both will contribute 50%. This difference between indexes is defined as Plutocratic Bias and is a source of study for several different authors, as already discussed in Section 2.

For our sample period, the Plutocratic Bias is, on average, -0.143 percentage points, ranging between -0.066 and -0.279. These results allow us to confirm that the Democratic inflation was consistently higher than the Plutocratic one, between 1994 and 2018. Hence, we should expect larger inflation rates for poorer households. Figure 1 shows the bias over time.

When comparing our estimations with the CPI, we evidence differences between them. As Hobijn & Lagakos (2005) refer, these differences can be explained by the substitution bias, given that we update the basket of consumption and weights in every period. The Plutocratic estimation was, on average, 0.112 higher each period. Figure 4 presents the three measures over the sample period.

Figure 1: Plutocratic Bias
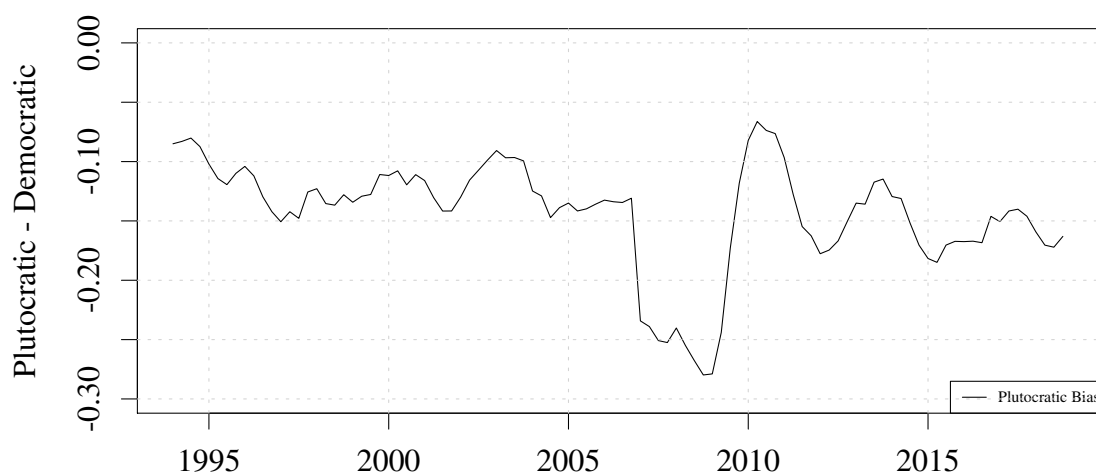
4.2 Inflation Representativeness

To understand how representative inflation can be, we must look at each household's specific inflation rate and compare it with the mean inflation. We analyse the dispersion of inflation across households. The more concentrated around the mean are the rates, the more representative inflation will be. Unequal inflations are caused by the variation in consumption patterns that lead each good to have a different weight in each household's basket. Also, is worth mentioning that we are applying a Democratic procedure to obtain our mean inflation, which the arithmetic mean of household's specific inflation rate, and our households' specific inflation rate is calculated as showed by Equation 4.

Figure 3 exhibits mean inflation and its quartiles. Dispersion is evident and is reasonable to analyse. From 1994 to 2018, the difference between first and third quartiles was, on average, 1.185 percentage points. The biggest difference occurred in the third quarter of 2008, when it was 2.754 percentage points and the smallest was in the third quarter of 1997 with 0.329 percentage points. Furthermore, Figure 5 provides the relationship between mean inflation and its standard deviation. With a correlation of 0.268, we can state that they are positively correlated, so we should expect more dispersion in periods of high inflation.

Being able to assume that inflation is, indeed, dispersed among households, it is now relevant to understand how far are households from the mean inflation and how representative this

one might be. For this purpose, we apply dispersion criteria suggested by Crawford & Old-field (2002).[7] The first criteria calculates the percentage of households that were 1 percentage points or less away from the mean inflation (Figure 6). The second one shows the percentage of households that were 25% or less away from the mean inflation (Figure 7).

Concerning the first measure, on average, 74.3% of the households experienced inflation rates 1 percentage point or less away from the mean. Moreover, there were 47 quarters below average and the smallest percentage was in the third quarter of 2008, when only 35.7% of the households complied with the criteria. Regarding the second measure, the average was 78.3%. There were 38 periods below the average and the smallest percentage occurred in the first quarter of 2016, when only 27.9% of the households were 25% or less away from the mean. Overall, these two measures support the initial analysis regarding the quartiles that inflation is dispersed among households. It also adds the fact that a considerable number of families is not represented by the mean, knowing that more than 25% were at a reasonable distance from it, as the first criteria shows.

4.3 Group Specific Inflation Rate

After concluding, in the previous sub-section, that inflation is dispersed among households, we will now group households by certain common characteristics and compare inflation between groups, in order to understand if inflation experiences are consistently different between groups. To perform this analysis, we will first create groups based on income levels. We divide our population in deciles of income, then in quartiles and compare the top 75% with the bottom 25%, we also divide in two and compare the top 50% with the bottom 50% and, lastly, we compare the inflation of the top 1% with bottom 90%. Moreover, we also study the differences between households with elderly people against the ones without and also families with children and families without, given that these groups have very specific consumption patterns which might deliver significantly different inflation experiences.

[7]Leicester et al. (2008) also apply these two measures

4.3.1 Inflation by Decile of Income

As discussed previously, the variation in inflation rates expressed in this study surges due to differences in the consumption patterns, given that we must assume that all households face the same price for a certain good. Firstly, we focus on the basket of goods of each decile and the differences between groups. Table 3 shows the average relative importance of each group of goods in the basket of each decile, between 1994 and 2018. The most relevant differences surge in "Food at Home", where it has a much higher importance in poorer households baskets. decile 1 spent, on average, 20.62% of its budget in food to be consumed at home, while the tenth decile only 11.15%. The contrast between basic need goods and superfluous goods is notorious when analysing the baskets. "Utilities", just like electricity, gas or water, or "Health Care" play a much more important role in lower deciles, while "Entertainment", "Apparel", "Food Away" or "Personal Care" have larger weights in the richer baskets. Figure 8 presents the variation over time of the relative importances for decile 1, decile 10 and the mean. The importance of each good is consistent over time, for both deciles, in general, but with a significant seasonality, given that we are working with quarterly data. Furthermore, it is worth mentioning the behaviour of "Shelter" for the first decile, which became much more important during the Great Recession.

Secondly, we look at the price evolution of each group of goods, because only if these vary between them we will have different inflation rates. Table 4 provides the average price variation of each group. Basic need goods like "Food at Home", "Utilities", "Shelter" or "Health Care" registered price changes higher than 2%, while "Entertainment" or "Apparel" had lower and even negative price changes.

When calculating the specific inflation rates of each decile, we find evidences favouring the disparity of prices experienced by groups of income. Table 5 shows the inflation rate experienced by each decile, and also the population mean, between 1994 and 2018. decile 2 and decile 3 were the ones with higher inflation rates over the sample period, on average 2.59%, while decile 10 was the one with lower inflation, on average 2.35%. Furthermore, the lower deciles faced consistently higher-than-average rates, while top deciles faced lower-than-

Figure 2: Inflation: Mean, Decile 2 and Decile 10
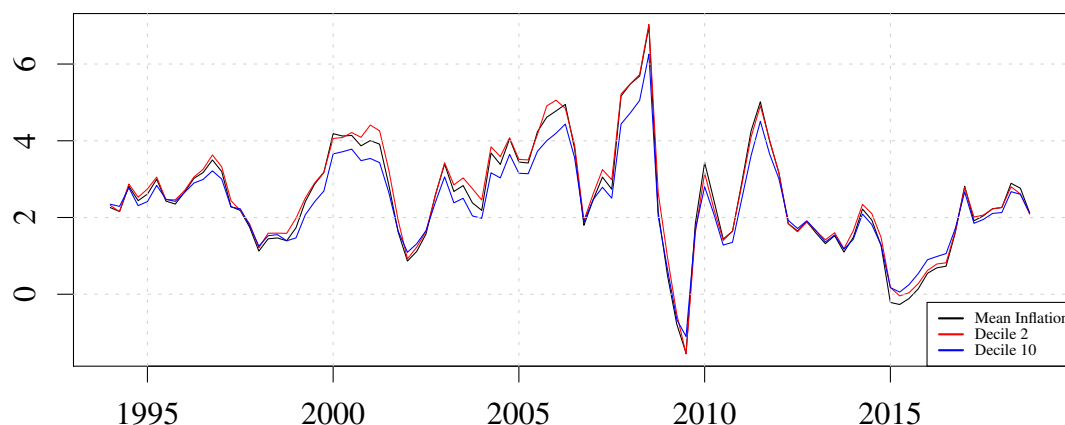
Notes: Inflation, over time, for Mean Population, decile 2 and decile 10. Values in percentage.

average inflation, which was already expected based on our comparisons between Plutocratic and Democratic estimations. Lastly, it is noteworthy the fact that during the two recessionary years observed in our time period, 2001 and 2008, the bottom Deciles experienced higher inflation rates than top deciles, as evidenced Table 5.

Figure 2 presents the variation, over time, of inflation experiences for the mean population, decile 2 and decile 10, while Figure 9 shows the yearly difference between decile 2 and decile 10. The mean difference was 0.24pp and reached its maximum of 0.91pp in the fourth quarter of 2005. In yearly terms, the year with the biggest difference was in 2008, with 0.7pp and the average yearly difference was 0.24pp.

To get a clearer picture of how much the heterogeneous inflation can impact the consumption possibilities of different households, we compute the Net Present Value (NPV) for the consumption of each decile. We assume an initial cash flow of $100 that is deducted to real terms, each year, based on the specific inflation of each decile. A common discount rate of 0.96 is applied to all deciles. The NPV reflects the inter-temporal purchasing conditions of each decile, assuming that more consumption will deliver more utility to households. Differences in NPV are due to specific inflation rates, which affect each decile during the years studied. Equation 5 provides the mathematical expression, with i as the decile in question, t the time period,

that goes from 0 to 25 and *PV* as the Present Value at time *t*. The Present Value is expressed as: $PV_{i,t} = \frac{C_t}{\pi_{t,i}} 0.96^t$ with C_t as the cash flow at time *t* and equal to $\frac{C_{t-1}}{\pi_{t-1,i}}$, the cash flow of the previous period deducted by the specific decile inflation rate of the period, $\pi_{t-1,i}$.

$$NPV_i = \sum_{t=0}^{t} PV_{i,t} \tag{5}$$

We conclude that the NPV of decile 10 was, for the 25 years studied, 2.33% higher than the NPV of decile 2. This means that specific inflation impacted the different groups of income differently and had a direct impact on their consumption needs, cost-of-living and the utility that is originated from it. Hence, richer households were able to consume comparatively more than poorer ones.

Table 6 provides the NPV of each decile and Table 1 compares the NPV's of each decile in terms of percentage gain. We can conclude that lower deciles, specially the bottom 3 deciles had lower NPV's when compared to the average of the population and to the higher deciles, as second, third and fourth columns exhibit. With this, we are able to confirm that specific inflation fostered the gap in the consumption possibilities and utility that households are expected to obtain from it.

Table 1: NPV percentage gain between Deciles

	Population Mean Inflation	Plutocratic Inflation	1	2	3	4	5	6	7	8	9	10
Population Mean Inflation	0.00	1.15	-0.70	-0.88	-0.81	-0.54	-0.14	0.01	0.32	0.62	0.96	1.43
Plutocratic Inflation	-1.14	0.00	-1.83	-2.01	-1.94	-1.67	-1.27	-1.13	-0.82	-0.52	-0.19	0.28
1	0.70	1.86	0.00	-0.18	-0.12	0.16	0.57	0.71	1.02	1.33	1.67	2.15
2	0.89	2.05	0.18	0.00	0.07	0.35	0.75	0.89	1.21	1.51	1.86	2.33
3	0.82	1.98	0.12	-0.07	0.00	0.28	0.68	0.83	1.14	1.45	1.79	2.27
4	0.54	1.70	-0.16	-0.34	-0.28	0.00	0.40	0.55	0.86	1.16	1.51	1.98
5	0.14	1.29	-0.56	-0.74	-0.68	-0.40	0.00	0.14	0.45	0.76	1.10	1.57
6	-0.01	1.14	-0.70	-0.89	-0.82	-0.54	-0.14	0.00	0.31	0.61	0.95	1.43
7	-0.32	0.83	-1.01	-1.19	-1.13	-0.85	-0.45	-0.31	0.00	0.30	0.64	1.11
8	-0.62	0.52	-1.31	-1.49	-1.43	-1.15	-0.75	-0.61	-0.30	0.00	0.34	0.81
9	-0.95	0.19	-1.64	-1.82	-1.76	-1.48	-1.09	-0.95	-0.64	-0.34	0.00	0.47
10	-1.41	-0.28	-2.10	-2.28	-2.22	-1.94	-1.55	-1.41	-1.10	-0.80	-0.47	0.00

Notes: The table presents a comparison between NPV's. The values represent the percentage gain/loss of the NPV of one decile, the Population Mean Inflation (Democratic inflation index) and Plutocratic Inflation, in columns, when compared to another decile or to the mean, in rows.

4.3.2 Inflation by Other Groups of Income

In this subsection, we group the population into larger fractions of income. When comparing the top 75% with the bottom 25%, we conclude that the average difference was 0.21pp, with the poorer 25% experiencing higher inflation rates, between 2000 and 2018, as Figure 10 and Table 7 show. The biggest difference occurred in 2008, amounting to 0.5 percentage points. Applying the same procedure as before, the NPV for the bottom 25% was 2% lower than the top 75% one. Furthermore, the bottom 50% of income presented inflation rates 0.14pp higher than the top 50%. In terms of NPV, the top 50% was 1.4% higher.

Lastly, when comparing the top 1% of income with the bottom 90% we reach the biggest difference in terms of inflation experience. The bottom 90% faced price indexes 0.25pp higher than the top 1%, between 2003 and 2018, as presented in table 8. Figures 11 and 12 provide the difference between inflations over time. The biggest was in 2008 when the bottom 90% suffered an inflation 0.89pp higher. To conclude, the bottom 90% lost 2.6% of their NPV, when compared to the top 1%, in 16 years.

4.3.3 Inflation by Demographic Characteristics

For this study, we created two sub-groups based on households' characteristics. The first compares families with old cohorts with families without, while the second concerns households with children against households without.

Regarding the elderly, we consider a household with old people any household with, at least, one person older than 64 years old. In this case, we find that those with old individuals had an inflation 0.118pp higher, on average, which meets Leicester et al. (2008) conclusions. In terms of NPV, this difference leads to a loss for the households with old people of 1.2%, when compared to the ones without.

In terms of families with children, we conclude that these ones experienced prices 0.15pp lower, on average, between 2000 and 2018. This represents a gain of 1.3% when comparing the NPV's. Table 9 provides the inflation rates for the 4 groups over the sample period. Figures 13

and 14 provide the graphical representation of inflation rates over time of the 4 groups.

The inclusion of these two comparisons is justified by the fact that these groups tend to incur in very specific expenditures, that do not have such relevance in the typical household basket. Elderly people are expected to spent more in medical care than the average, while families with children in education, for example. Furthermore, the conclusion on households with elderly people is relevant because Social Security benefits are indexed to CPI-W and are an important part of these households' income. If indexation is not internalizing all increases in the cost-of-living, then these households are being harmed twice by inflation.

5 Policy Implications

5.1 Federal Income Tax

The American federal income tax system is composed by two main procedures, an itemized system and a deductible one, which households can choose from. In the first one, households decrease their taxable income based on the type of expenditures that they incur in, for example medical care or education. The second system sets fixed deductible amounts, meaning that all households that choose this mechanism can deduct directly from their income a certain value that will not be taxed. There are several different deductions, depending on the type of household: single households deduct different amounts than households declaring jointly, households with elderly cohorts are able to deduct more, as well as the ones with children or other dependents. Moreover, these deductions are indexed to CPI, in order to update the increases in costs-of-living. [8]

Based on our study, we indexed deductions to the specific inflation rate experienced by decile 1 and compared it with the real deductions. As Table 10 shows, in 2017, a single household could officially deduct $10,400 from its income, meaning that if the household received

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[8]For a complete explanation and a historical perspective on marginal tax rates and deductions, see CRS Report RL34498, Individual Income Tax Rates and Other Key Elements of the Federal Individual Income Tax: 1988 to 2019 Tax Years, by Gary Guenther.

less than this, we should expect him not to pay any federal income tax. When indexing to inflation of decile 1, the deductible income increases to $11,150, leading to a difference of $750. We expanded the types of households and present many different combinations of households and the respective deductible income, as presented in Table 10. *Single* means that is a single household facing the *Standard Single Deduction*, *OLD* indicates a household where there is one individual with more than 64 years, which is under a different deduction value. *Joint* indicates that a couple declares its tax statement jointly and faces the *Jointly Standard Deduction*. *Head of Household* applies to all non-married households that are responsible for financial dependent individuals, just like children. The "+ *x*" indicates the number of financial dependent individuals the household is composed by. Finally, it is also relevant to mention that until 2017 a *Personal Exemption* was applied to each member of the household. In 2018 the Federal Income tax system was reformed and this *Personal Exemption* was retrieved, increasing the values of the other deductions. Our analysis is performed in 2017 because the 2018 reforms were not directly linked to increases in inflation.

We compute how many households had income levels inside the gap between the estimated and the official deductible incomes. In 2017, based on our population sample from the Consumer Expenditure Survey, this number amounted to around 1.77 million households. This allows to state that these households could be paying taxes when they should not, due to an indexation that does not completely reflect their increases in the cost-of-living. We are not able to specify the exact number and just able to estimate how much are eligible, because households can choose between itemized and deductible mechanisms, and we do not have information regarding which one a household uses.

5.2 Cost-of-Living Adjustment (COLA)

Since 1975 that Social Security general benefits have been indexed to CPI-W (the CPI for Urban Wage Earners and Clerical Workers) in order to compensate for the increases in the cost-

of-living. These yearly adjustments are denominated as "Cost-of-Living Adjustment".[9] In this section, we compare the adjustments with our estimates and understand the impact of this gap on each decile income and compensation for the increase in the cost-of-living. As suggested by Leicester et al. (2008), we also apply this to households with individuals older than 64 years, given that Social Security pensions and retirement funds play a vital role in the income of these families and the inflation experienced by them tends to be significantly different, as concluded previously.

Table 11 indicates the conclusions from our comparisons. If COLAs were indexed to the specific inflation rate of each decile, then we would expect that households from decile 2 were receiving Social Security benefits 9.70% higher, in 2018. This conclusion is even more relevant given that Social Security benefits represented 57% of the income for households in decile 2, in 2018. Furthermore, all deciles evidence an increase in benefits because we are calculating based on the democratic estimations that were higher than the CPI-U and CPI-W, on average, during our sample period.

In terms of households with elderly cohorts, whose funds and pensions represent 34% of their income, we also conclude that these should be receiving Social Security benefits 6.68% higher. The study for these groups only includes the years between 2000 and 2018.

5.3   Monetary Policy

Inflation rate is a crucial indicator when performing monetary policy and setting the Federal Funds Rate. Since 2000, the Federal Reserve uses the Personal Consumer Index excluding food and energy (Core PCE) as official inflation index.

The weights in the Personal Consumer Expenditure index are defined based on surveys to retail and services such as the Monthly Retail Trade Survey and the Quarterly Services Survey. This index does not reflect the weights of the goods based on what consumers spend, but through what is sold by businesses. Hence, is not possible to compute a Democratic in-

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[9]To access more information about COLA, see: https://www.ssa.gov/oact/cola/colasummary.html

dex based on PCE, because we do not have households' specific inflation rates. Also, PCE and CPI have different scopes: while the first includes all expenditures incurred on behalf of consumers, CPI only integrates out-of-pocket consumption. In practical terms, this implies that PCE includes employees insurance costs supported by companies, or education paid by the Government. Overall, the weights are not equal between indexes, leading to very different inflation levels, with CPI presenting higher values, on average. Furthermore, due to methodology procedures, a match between the two indexes is not easy to obtain, being this a topic discussed by a wide range of academics, such as Johnson (2017) and Blair (2013).

In this section, we compare the Core PCE with our Democratic Core Inflation. As mentioned previously, FED is now leading more inclusive policies, trying to deliver more wealth to poorer groups. In order to achieve this, we believe that a Democratic index can deliver more accurate and precise inflation rates, given that will reflect better the experience of poorer households. Not being possible to achieve this through PCE and the surveys that support it, we apply our data from CE to analyse the potential impacts of Democratic indexes on monetary policy.

In our Democratic Core Inflation, we do not include goods such as food or energy, because these tend to evidence a strong volatility, hence they are retrieved from estimates in order to guarantee more stable indicators. We compare both indexes and the respective impacts on monetary policy conducted by the Federal Reserve through the computation of a Taylor's Rule. The Taylor's Rule is an equation widely used by Central Banks that sets the optimal fund rate based on the output gap, the observed inflation, the equilibrium interest rate and optimal inflation rate. It was proposed by Taylor (1993) and is still a benchmark for the conduction of monetary policy. Mathematically, the equation is defined as:

$$i_t = r^* + \pi_t + 0.5(Y_t - Y^*) + 0.5(\pi_t - \pi^*) \tag{6}$$

Where, i_t is the optimal Federal Funds Rate defined by Taylor's Rule for period t, r^* is the equilibrium interest rate, which we define as 2%, in accordance to Taylor (1993), π_t is the observed inflation rate, Y_t is the output at time t, Y^* is the potential output and π^* is the defined

optimal inflation, which we set at 2%.

When applying to the two indexes, we conclude that, on average, the fund rates should be 0.8pp higher, between 1994 and 2018, if the FED used a Democratic index that weighted all households the same. The biggest difference occurred in 2018, when our estimated rate was 5.38% and the rate with Core PCE was 3.53%. Table 12 and Figure 7 provide the variation of the two indicators over time and compare it to the official FED Funds Rate.

As Brinca et al. (2019) states, poorer households tend to be more constraint by debt and have lower liquidity levels. A higher interest rate, as the one proposed, would harm them, given that debt becomes more expensive. Thus so, a contradiction surges, between the aim to obtain a Federal Funds Rate more representative of poorer households and the negative impact that this one would end up having on these groups. This is an issue worth exploring through models with heterogeneous agents in order to reach an optimal interest rate, able to balance the two effects. Lastly, the difference to the official rate is notorious, being evident that the Taylor's Rule is not the only procedure used by the FED when setting the Funds Rate.

6   Conclusion

Price indexes have been a topic of study for years. Our study contributes to this discussion by tackling the representativeness of CPI among households and the differences on inflation between groups of income and other aggregations based on common characteristics, focusing on a very recent sample period. Also, we deliver value-added through the analysis of potential policy impacts, if policies were designed taking into account inflation heterogeneity across households, specially the formulation of a Democratic core inflation index to support the conduction of monetary policy.

With data retrieved from the Consumer Expenditure Survey, we were able to create baskets of consumption for each household and compute a specific inflation rate for each one between 1994 and 2018, in the United States. We conclude that price indexes differ significantly

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between households and many are far away from the mean inflation. Moreover, by updating the weights of each good in each time period, we minimized the substitution bias. When accessing the differences between Plutocratic and Democratic estimates we confirm the dispersion of inflation rates and the fact that the CPI created a bias in favour of richer households during the sample period.

By grouping households in deciles of income, we confirmed this bias towards the richer, concluding that poorer households experienced, on average, higher inflation rates. The decile 2 was the one who suffered the most and decile 10 the one who registered lower inflation rates during the studied years, being 0.24pp the yearly difference between them, on average. When comparing these two deciles, we state that the Net Present Value for inter-temporal consumption of decile 10 was 2.33% higher than the NPV of decile 2, for the period between 1994 and 2018, meaning that decile 10 experienced an increase in its consumption possibilities, comparing to decile 2. Other relevant conclusion arises when we study the inflation rates of the bottom 90% of income and the top 1%. Here, we conclude that between 2003 and 2018, the bottom 90% experienced prices 0.25pp higher than the top 1%, and lost 2.6% of its NPV when compared to the top 1%. Furthermore, the contrast between households with elderly cohorts and without shows that the first experienced higher inflation rates, just as households without children when compared to the ones without.

In terms of policy implications, we analysed the influence of these results for the indexation of Federal Income Taxes and Social Security benefits. We conclude that 1.77 million households could be paying federal income taxes in 2017 when they should not if deductions were indexed to the specific inflation rate of decile 1, instead of CPI. Households in decile 2 and the ones with elderly cohorts would receive Social Security benefits 9.7% and 6.68% higher, respectively, in 2018, if COLAs were indexed to their specific inflation rates. In terms of monetary policy, based on Taylor's Rule, we conclude that the Federal Funds Rate would be 0.8 percentage points higher, on average, during the sample period, if FED used an index that weighted all households the same, instead of the current procedure that weights each household

based on the level of its expenditures, delivering more importance to richer ones.

This study did not address some questions, such as the difference in price experiences for a specific good. We assumed that all households face the same price when buying the same good, even though we know that this is not entirely true. Specific data is still not widespread and easily available, although there are some studies concerning this issue.[10] Addressing this question and its implications is a starting point for future research. Another question that arises from this study is the discussion on the optimal interest rate set by FED. We conclude that, if FED followed a Democratic core inflation index, weighting each household with the same importance, the optimal interest rate would be 0.8pp higher. This would make debt more expensive, harming indebted households. Assuming that poorer households are the most indebted ones, this policy would not be optimal to them and would promote an even larger gap between the consumption possibilities of rich and poor. In order to study the impact of this conclusion and balance the consequences arising from setting an optimal rate, we should apply these results to models with heterogeneous agents, in future research.

Overall, we conclude that each household experiences different inflation rates and that has direct impact in their consumption and cost-of-living, which is not taken into account by official indicators. Furthermore, indexation of governmental fiscal systems and monetary policy do not account for this issue, fostering the gap even more and harming households twice. Thus, there is an increasing gap in consumption possibilities between groups of income that is being neglected, because richer households have been experiencing lower inflation rates, which allows them to consume comparatively more than poorer households.

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[10]see: Jaravel (2019) and Argente et al. (2018)

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7 Appendix

<div align="center">

Table 2: Match CE with CPI

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| CE	CPI
Food at Home	**Food at Home**
(Food purchased at grocery stores or other food stores, excluding alcoholic beverages)	
Food Away	**Food Away**
(Food consumed away from home)	
Alcoholic Beverages	**Alcoholic Beverages**
(purchashed for home or away consumption)	
Shelter	**Shelter**
(Owned dwellings, rented dwellings and other lodging)	
Utilities	**Fuels and Utilities**
(Electricity, water, natural gas, other fuels and garbage collection)	
Household	**Household Furnishings**
(Furnishings, decorations, domestic services, child care, etc)	**and Operations**
Apparel	**Apparel**
(Clothes)	
Vehicles	**New and Used Motor Vehicles**
(New and used cars and other vehicles)	
Other Vehicles	**Vehicle Parts and Equipment**
(Other expenses with vehicles)	**Vehicle Insurance**
	Vehicle Fees
	Vehicle Maintenance and Repair
Gasoline	**Motor Fuel**
Public Transportation	**Public Transportation**
Health Care	**Medical Care**
(Health insurance, medical services and drugs)	
Entertainment	**Recreation**
(fees and admissions, television, audio and video equipment, pets, toys, hobbies, other entertainment equipment)	
Personal Care	**Personal Care**
(Personal goods and services)	
Telephone Services	**Telephone Services**
Education	**Education**
(Tuition fees and educational equipment)	
Tobacco	**Tobacco**

Figure 3: Mean Inflation and Quartiles
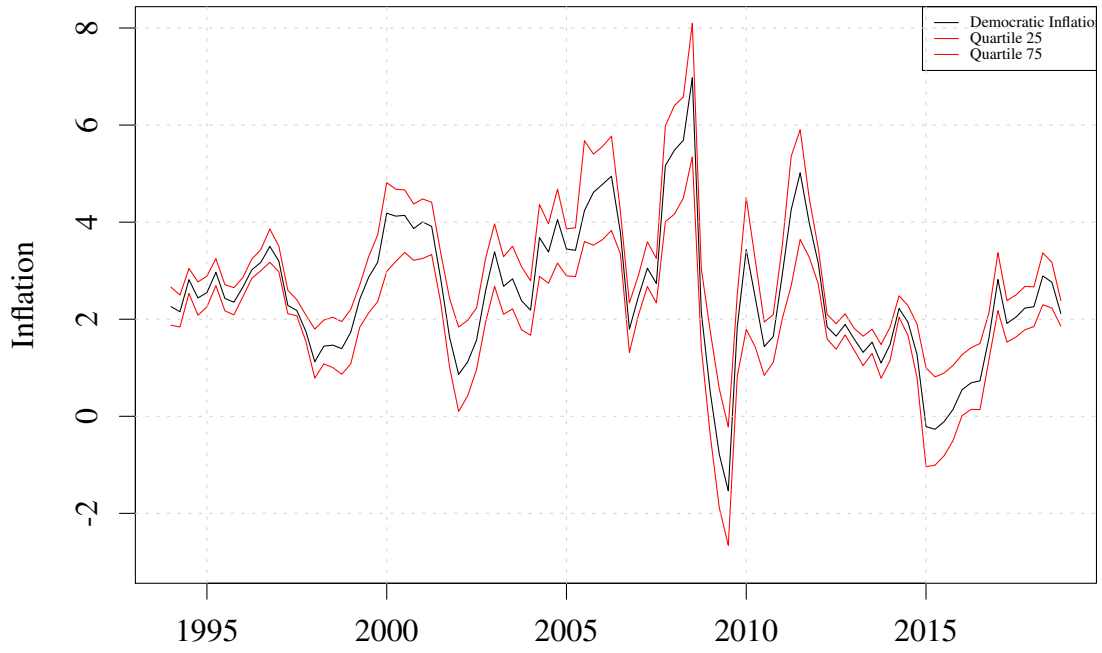
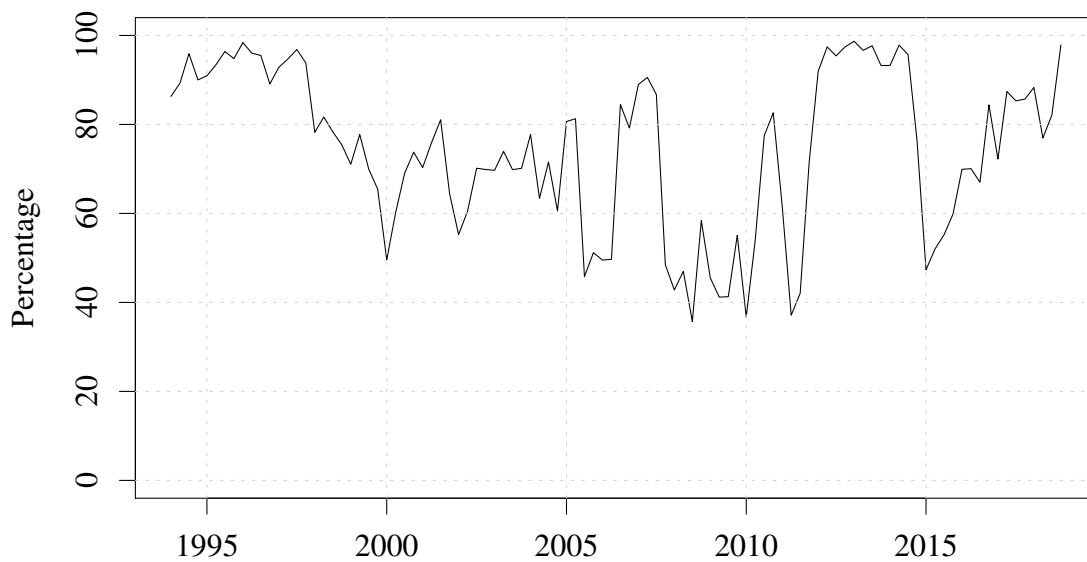**Figure 4:** Inflation Measures
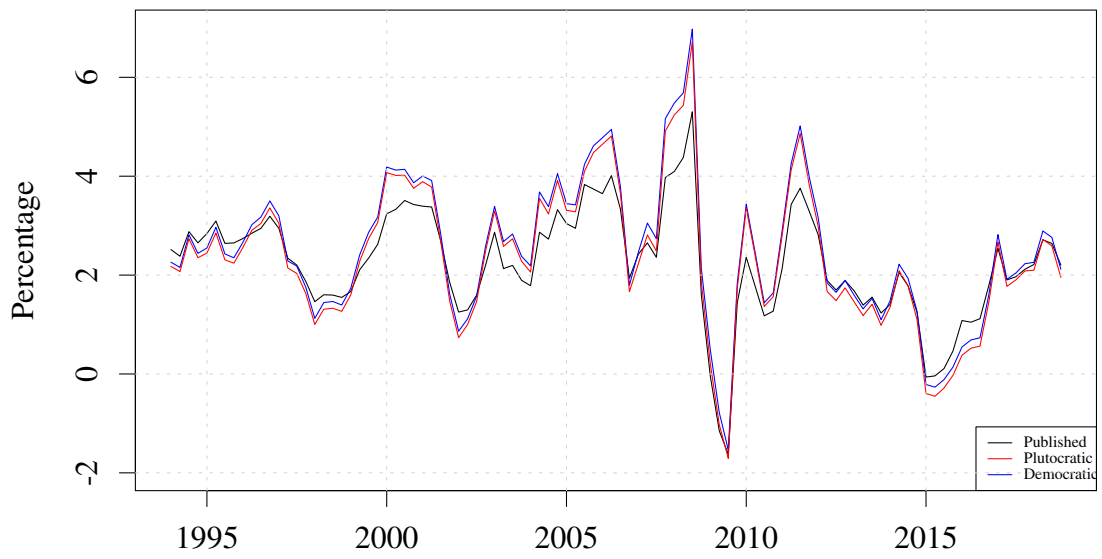
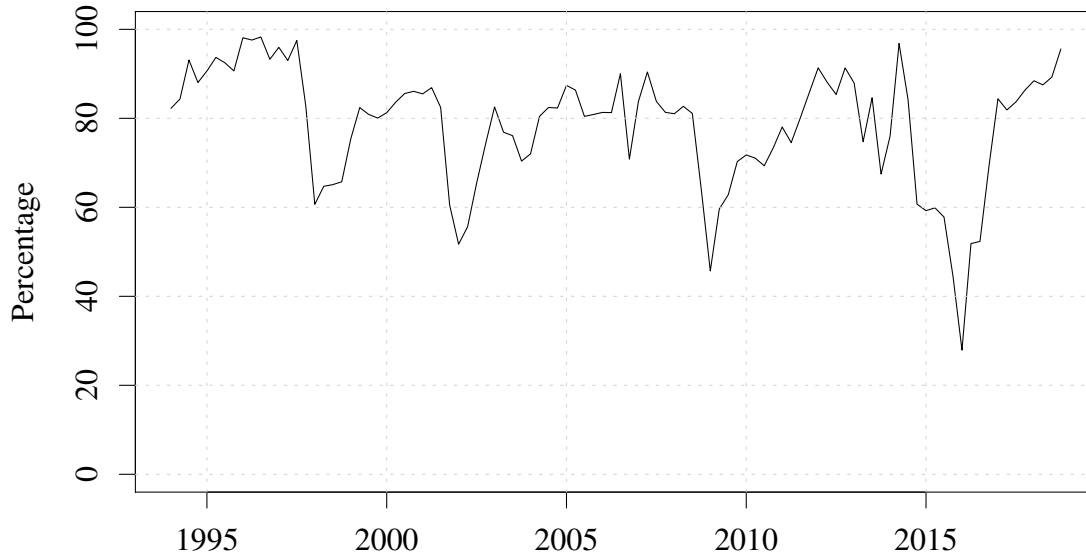**Figure 5:** Mean Inflation and Standard Deviation
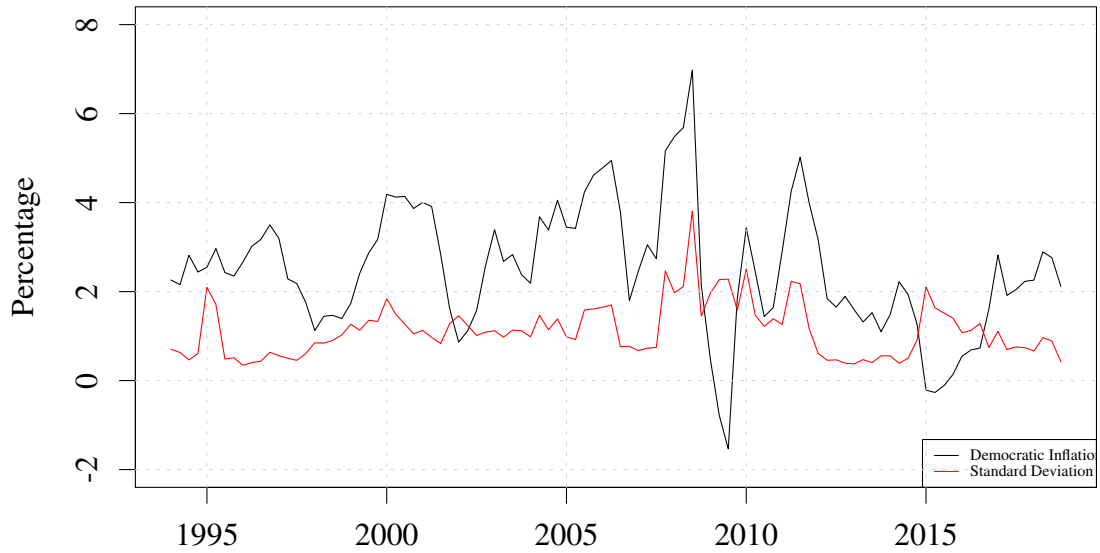
Figure 6: First Measure of Dispersion

Notes: Percentage of Households were 1 percentage point or less away from mean inflation.

Figure 7: Second Measure of Dispersion

*Notes*: Percentage of Households were 25% or less away from mean inflation.

Table 3: Relative Importances by Decile of income

Groups of Goods	Mean	1	2	3	4	5	6	7	8	9	10
Food Home	15.94	20.62	19.59	18.09	17.01	16.10	15.26	14.45	13.67	12.82	11.15
Food Away	5.36	5.14	4.17	4.62	4.96	5.28	5.54	5.64	5.84	6.09	6.45
Alcoholic Beverages	1.03	1.05	0.80	0.85	0.96	1.02	1.07	1.05	1.11	1.12	1.24
Shelter	25.40	26.24	25.81	25.17	24.77	24.98	25.06	24.78	25.07	25.19	27.17
Household	3.21	2.20	2.35	2.58	2.69	2.84	3.10	3.41	3.77	4.23	5.15
Utilities	7.60	8.56	9.63	8.92	8.33	7.85	7.33	6.98	6.57	6.11	5.47
Apparel	3.32	3.35	2.76	2.85	2.98	3.16	3.24	3.37	3.53	3.77	4.30
Vehicles	4.62	2.12	2.40	3.25	4.30	4.90	5.40	5.94	6.25	6.28	5.56
Vehicles Other	5.38	3.60	4.06	4.85	5.38	5.65	5.97	6.11	6.09	6.25	6.02
Gasoline	5.75	5.16	5.00	5.69	6.04	6.31	6.35	6.29	6.09	5.80	4.70
Public Transportation	0.97	0.95	0.75	0.78	0.80	0.80	0.85	0.90	1.00	1.21	1.75
Health Care	8.34	7.05	9.96	10.06	9.46	8.61	8.02	8.14	7.78	7.46	6.62
Entertainment	5.89	5.17	4.92	5.02	5.25	5.54	5.89	6.16	6.56	7.01	7.54
Personal Care	0.95	0.93	0.90	0.92	0.92	0.93	0.93	0.95	0.98	1.02	1.07
Telephone	3.74	4.07	4.25	4.07	3.97	3.91	3.83	3.67	3.48	3.26	2.77
Education	1.24	2.03	0.93	0.70	0.70	0.71	0.87	1.00	1.25	1.64	2.60
Tobacco	1.27	1.77	1.73	1.58	1.50	1.41	1.30	1.15	0.97	0.75	0.45

Notes: The table presents the relative importance of each group of goods in the consumption basket of each decile of income and also of population mean. Values are in percentage.

Figure 8: Relative Importance of each Group of Goods
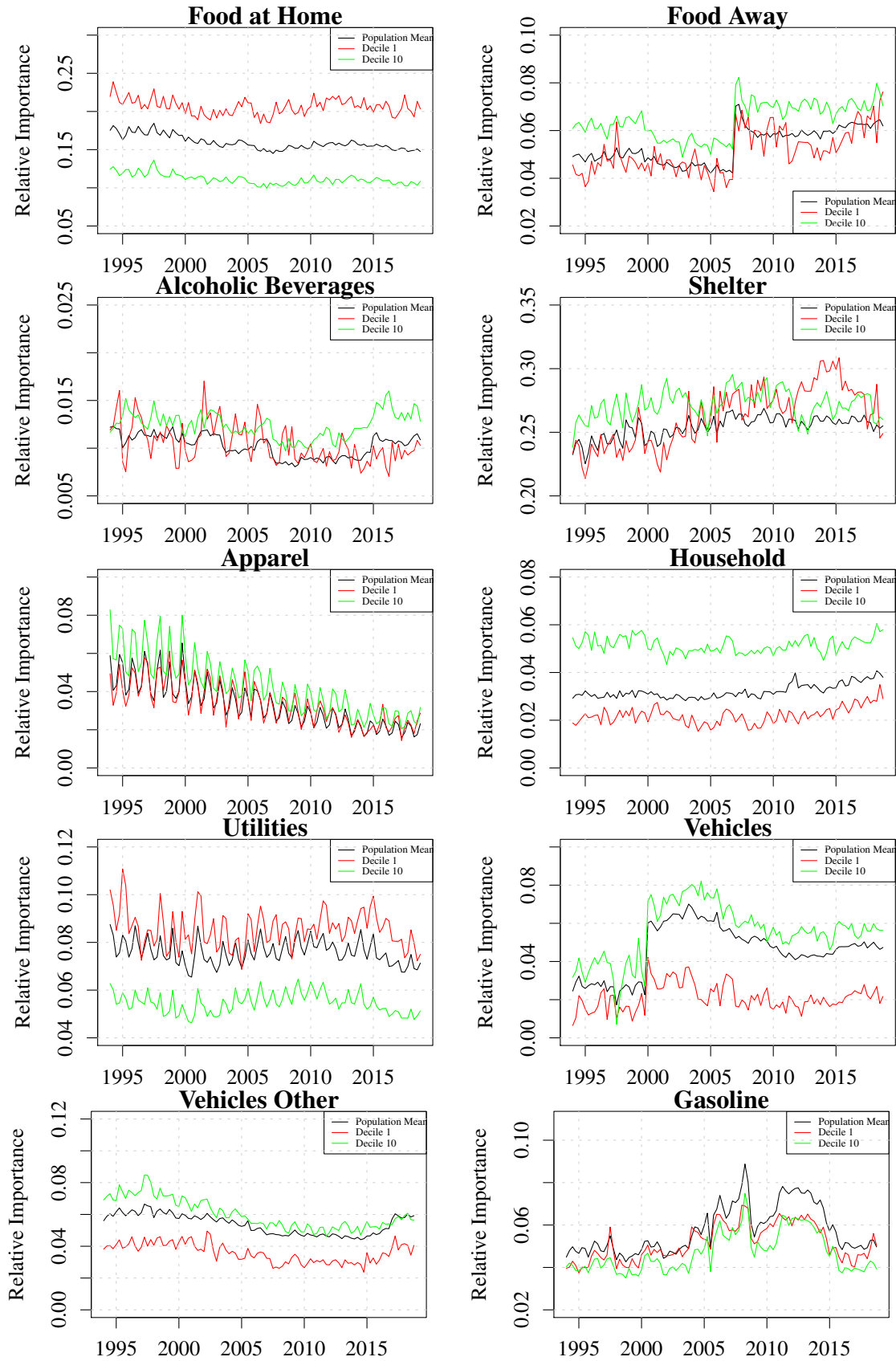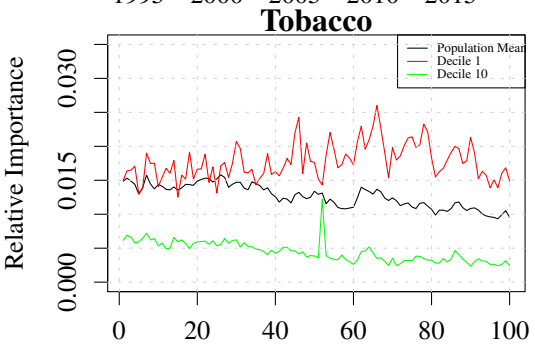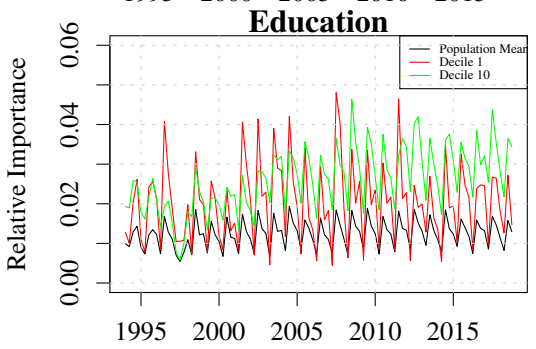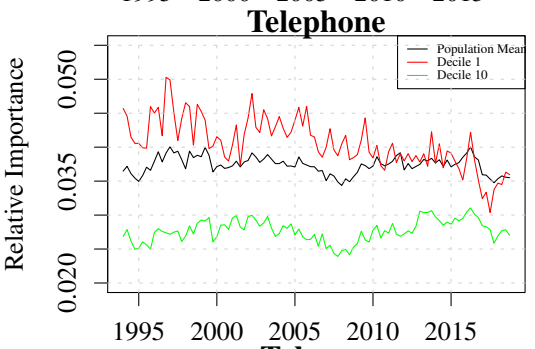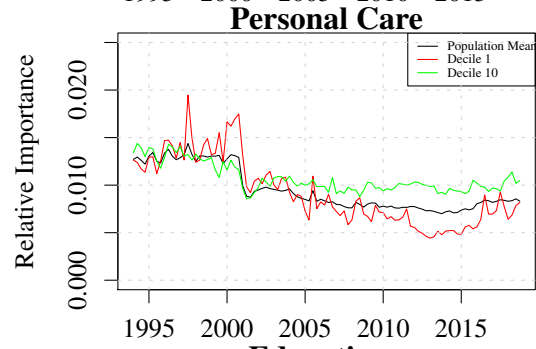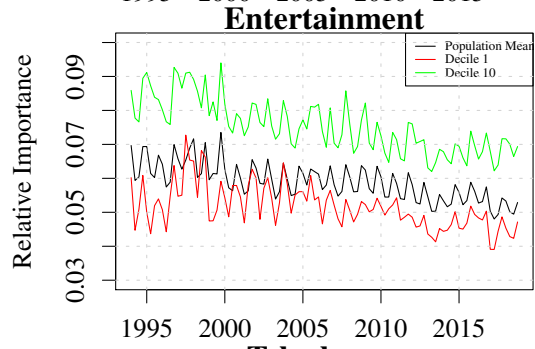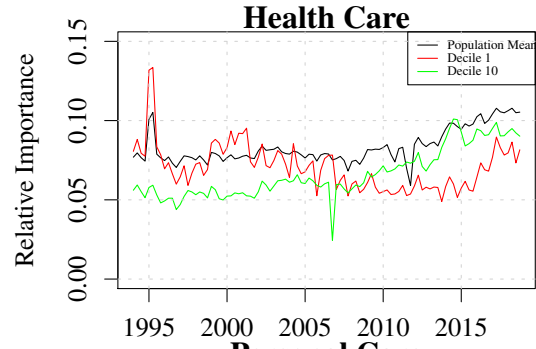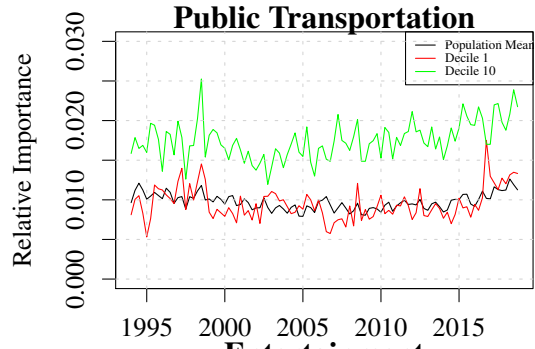
Table 4: Mean Inflation by groups of goods

Groups of Goods	Mean Inflation (1994-2018)
Food Home	2.19%
Food Away	2.66%
Alcoholic Beverages	2.07%
Shelter	2.77%
Household	0.08%
Utilities	2.91%
Apparel	-0.24%
Vehicles	0.32%
Vehicles Other	2.76%
Gasoline	5.43%
Public Transportation	1.85%
Health Care	3.58%
Entertainment	1.10%
Personal Care	1.98%
Telephone	-0.17%
Education	4.90%
Tobacco	6.61%

Notes: The table presents the inflation mean of each group of goods between 1994 and 2018.

**Table 5:** Yearly Inflation Rate by Decile of Income

Years	Population Mean Inflation	1	2	3	4	5	6	7	8	9	10
1994	2.42	2.45	2.47	2.44	2.42	2.38	2.38	2.40	2.41	2.40	2.43
1995	2.60	2.66	2.68	2.63	2.62	2.60	2.56	2.57	2.55	2.54	2.54
1996	3.09	3.14	3.16	3.15	3.12	3.10	3.09	3.08	3.05	3.03	2.94
1997	2.35	2.39	2.44	2.41	2.37	2.35	2.36	2.31	2.30	2.29	2.33
1998	1.36	1.42	1.49	1.43	1.39	1.29	1.29	1.28	1.27	1.28	1.43
1999	2.55	2.64	2.64	2.66	2.69	2.60	2.63	2.52	2.45	2.37	2.16
2000	4.08	4.14	4.11	4.17	4.26	4.22	4.17	4.07	4.04	3.92	3.66
2001	3.09	3.32	3.46	3.32	3.19	3.08	3.02	2.95	2.91	2.82	2.82
2002	1.53	1.56	1.59	1.60	1.56	1.47	1.55	1.48	1.46	1.46	1.61
2003	2.82	2.99	3.02	3.06	2.90	2.88	2.84	2.77	2.65	2.57	2.50
2004	3.33	3.60	3.49	3.52	3.44	3.41	3.30	3.25	3.17	3.08	2.96
2005	3.93	3.96	4.02	4.10	4.03	4.02	4.02	3.96	3.85	3.79	3.51
2006	3.83	3.89	3.93	4.01	3.96	3.88	3.85	3.82	3.72	3.68	3.52
2007	3.36	3.62	3.52	3.56	3.49	3.40	3.34	3.27	3.14	3.14	3.05
2008	5.07	5.20	5.22	5.28	5.23	5.20	5.07	5.06	5.07	4.81	4.52
2009	0.00	0.20	0.12	-0.05	0.01	-0.09	-0.13	-0.08	-0.06	0.02	0.14
2010	2.24	2.09	2.11	2.27	2.33	2.38	2.41	2.35	2.31	2.23	1.88
2011	4.04	3.90	3.97	4.11	4.12	4.22	4.22	4.15	4.11	4.00	3.56
2012	2.14	2.12	2.13	2.14	2.12	2.13	2.15	2.15	2.15	2.15	2.14
2013	1.38	1.47	1.46	1.43	1.37	1.33	1.34	1.33	1.33	1.34	1.43
2014	1.73	1.95	1.89	1.84	1.74	1.69	1.68	1.63	1.61	1.59	1.65
2015	-0.11	0.15	0.11	-0.08	-0.23	-0.33	-0.36	-0.25	-0.22	-0.16	0.25
2016	0.90	0.83	0.97	0.87	0.85	0.81	0.84	0.83	0.87	0.95	1.17
2017	2.25	2.20	2.27	2.31	2.29	2.31	2.29	2.27	2.24	2.20	2.14
2018	2.51	2.44	2.44	2.54	2.56	2.57	2.57	2.53	2.53	2.51	2.38
Mean	2.50	2.57	2.59	2.59	2.55	2.52	2.50	2.47	2.44	2.40	2.35

Notes: The table presents the inflation rate experienced by each decile of income and the population mean, between 1994 and 2018. Values in percentage.

Figure 9: Inflation Difference Decile 2 and Decile 10
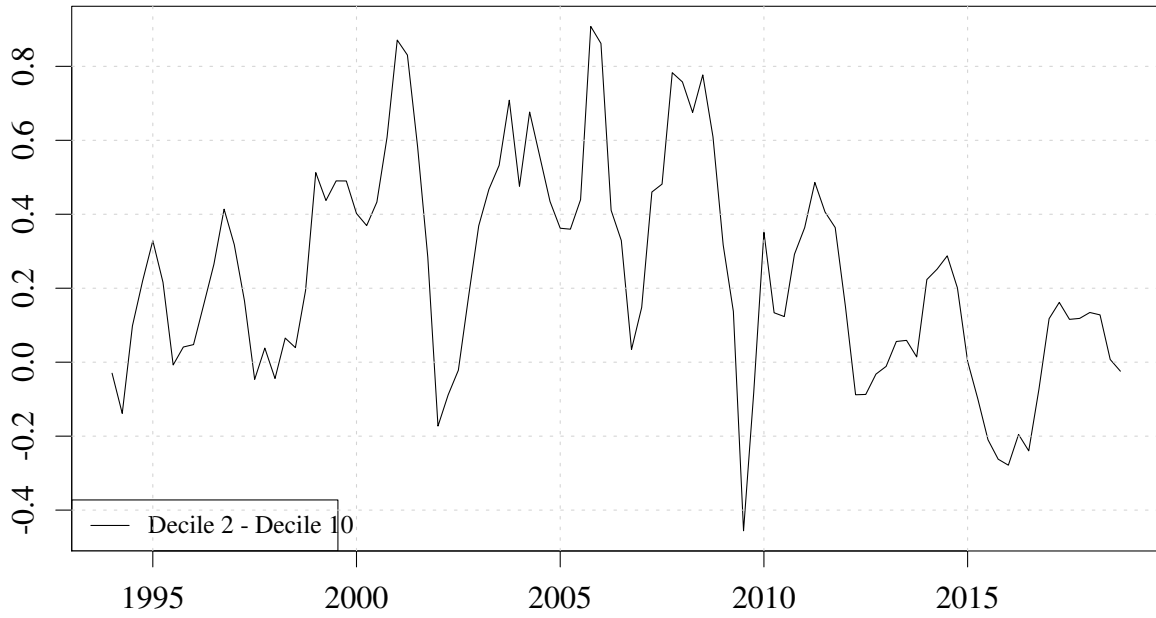
Notes: Inflation difference, over time, between decile 2 and decile 10. Values in percentage points.

Table 6: NPV per Decile of Income

Decile	NPV
Popualtion Mean	$1269.55
1	$1260.71
2	$1258.39
3	$1259.23
4	$1262.74
5	$1267.83
6	$1269.64
7	$1273.57
8	$1277.44
9	$1281.75
10	$1287.76

Notes: Net Present Value of each decile consumption. The initial consumption is $100, from each are discounted the specific inflation for each year. The discount rate is 0.96 and common to all groups. There are 25 yearly periods.

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Table 7: Inflation Rates Top 75% and Bottom 25%

	Top 75%	Bottom 25%
2000	3.83	4.12
2001	2.83	3.37
2002	1.53	1.58
2003	2.56	3.01
2004	3.04	3.55
2005	3.85	4.13
2006	3.63	3.93
2007	3.11	3.57
2008	4.58	5.13
2009	0.05	0.13
2010	2.24	2.19
2011	3.86	3.95
2012	2.15	2.12
2013	1.38	1.47
2014	1.62	1.91
2015	0.00	0.09
2016	1.03	0.89
2017	2.17	2.26
2018	2.46	2.46
Mean	2.42	2.62

Notes: Inflation Rates for top 75% and bottom 25% of income, between 2000 and 2018. Values in Percentage.

Figure 10: Inflation Difference Bottom 25% and Top 75%

Notes: Inflation difference, over time, between Bottom 25% of income and top 75%. Values in percentage points.

Table 8: Inflation Rates Top 1% and Bottom 90%

	Top 1	Bottom 90
2003	2.52	2.83
2004	2.81	3.36
2005	3.38	4.12
2006	3.27	3.90
2007	2.83	3.39
2008	4.09	4.98
2009	0.26	-0.01
2010	1.78	2.38
2011	3.21	4.09
2012	2.11	2.14
2013	1.52	1.38
2014	1.64	1.73
2015	0.60	-0.16
2016	1.29	0.87
2017	2.04	2.28
2018	2.32	2.52
Mean	2.23	2.49

Notes: Inflation Rates for top 1% and bottom 90% of income, between 2003 and 2018. Values in Percentage.

Figure 11: Inflation Difference Bottom 90% and Top 1%

Notes: Inflation difference, over time, between Bottom 90% of income and top 1%. Values in percentage points.

Figure 12: Inflation Bottom 90% (Black) and Top 1% (Red)

Notes: Inflation, over time, of Bottom 90% (black) of income and top 1% (red). Values in percentage.

Table 9: Inflation Rates Households with Elderly People and without; Households with Children and without

Years	Old	No Old	Children	No Children
2000	4.03	4.09	3.94	4.11
2001	3.52	2.96	2.92	3.17
2002	1.65	1.50	1.37	1.60
2003	3.12	2.72	2.62	2.88
2004	3.49	3.28	3.17	3.36
2005	4.22	4.04	3.94	4.09
2006	3.96	3.79	3.70	3.86
2007	3.44	3.33	3.21	3.40
2008	4.95	4.92	4.84	4.92
2009	0.22	-0.06	-0.21	0.11
2010	2.22	2.39	2.22	2.34
2011	3.84	4.11	4.06	3.99
2012	2.16	2.13	2.10	2.14
2013	1.47	1.35	1.29	1.42
2014	1.84	1.68	1.62	1.77
2015	0.06	-0.18	-0.25	-0.04
2016	1.08	0.83	0.73	0.97
2017	2.26	2.26	2.18	2.29
2018	2.38	2.56	2.49	2.51
Mean	2.63	2.51	2.42	2.57

Notes: Inflation Rates for households with elderly people, without elderly, households with children and without children, between 2000 and 2018. Values in Percentage.

Figure 13: Inflation Households with Old people and without

Notes: Inflation, over time, of Households with old people and without. Values in percentage.

Figure 14: Inflation Households with Children and withouth

Notes: Inflation, over time, of Households with Children and without. Values in percentage.

Table 10: Federal Income Tax Deductions in 2017

Type of Household	Maximum Deductible Income	Estimated	Difference
Single	10400	11150	750
Single OLD	11950	12850	900
Joint	20800	21400	600
Joint + 1	24850	25750	900
Joint + 2	28900	30100	1200
Joint + 3	32950	34450	1500
Joint + 4	37000	38800	1800
Joint + 5	41050	43150	2100
Joint + 6	45100	47500	2400
Joint + OLD	22050	22700	650
Joint + OLD + 1	28400	29500	1100
Joint + OLD + 2	34750	36300	1550
Joint + 2OLD + 1	29650	30800	1150
Joint + 2OLD+ 2	36000	37600	1600
Head of Household + 1	17450	18750	1300
Head of Household + 2	21500	23100	1600
Head of Household + 3	25550	27450	1900
Head of Household + 4	29600	31800	2200
Head of Household + 5	33650	36150	2500
Head of Household + 6	37700	40500	2800
Head of Household + OLD	19000	20050	1050
Head of Household + OLD + 1	23050	24400	1350
Head of Household + OLD + 2	27100	28750	1650
Head of Household + 2OLD	24600	25700	1100
Head of Household + 2OLD + 1	28650	30050	1400
Head of Household + 2OLD + 2	32700	34400	1700

Notes: This table presents the Federal Income Tax deductions in 2017 for the different type of households. The maximum deductible income column provides the official values for 2017. The Estimated column includes the deductions if these were indexed to decile 1 specific inflation rates. The difference column show the monetary difference between the previous two. All values are in dollar terms.

Table 11: Cost-of-Living Adjustments; impact from different indexations

|	% Social Security in Total Income	Percentage Difference COLA's	Total New Income from SS	Estimated Additional Income
Decile 1	38%	9.29%	$2,439,833	$207,492
Decile 2	57%	9.70%	$10,123,273	$895,236
Decile 3	40%	9.70%	$11,046,851	$978,101
Decile 4	31%	8.80%	$11,864,463	$959,125
Decile 5	20%	7.85%	$9,754,182	$709,703
Decile 6	12%	7.38%	$7,354,894	$505,805
Decile 7	7%	6.56%	$5,683,668	$349,733
Decile 8	5%	5.74%	$5,245,518	$284,883
Decile 9	3%	4.87%	$4,227,965	$196,318
Decile 10	1%	3.55%	$2,701,495	$92,628
Households with Old*	34%	6.68%	$59,729,788	$3,739,469

Notes: This table presents the Social Security benefits and their importance in the income of each decile and also for households with elderly cohorts, in 2018. The percentage difference in COLA's indicates how much would each decile be receiving if the Cost-of-Living Adjustments were indexed to each decile specific inflation rate, between 1994 and 2018. Moreover, is important to mention that the analysis for households with elderly individuals was performed between 2000 and 2018, only.

Table 12: Federal Fund Rates based on Taylor's Rule

Years	FED Inflation	Democratic Core Inflation	Output Gap	Official Taylor Rule	Estimated Taylor Rule	Fed Funds Rate
1994	2.20	2.59	-1.07	3.77	4.36	4.20
1995	2.10	2.67	-1.03	3.64	4.49	5.84
1996	1.90	2.73	-0.13	3.79	5.03	5.30
1997	1.48	2.48	0.80	3.61	5.12	5.46
1998	1.27	2.51	1.24	3.53	5.38	5.35
1999	1.45	2.56	1.74	4.05	5.71	4.97
2000	1.80	2.44	1.64	4.52	5.48	6.24
2001	1.73	2.77	-0.97	3.10	4.68	3.89
2002	1.73	2.62	-2.16	2.51	3.85	1.67
2003	1.40	1.78	-2.00	2.10	2.67	1.13
2004	2.15	1.91	-1.00	3.73	3.37	1.35
2005	2.17	2.24	-0.25	4.14	4.24	3.21
2006	2.27	2.61	0.20	4.51	5.02	4.96
2007	2.25	2.70	0.07	4.41	5.09	5.02
2008	1.55	2.64	-1.86	2.39	4.02	1.93
2009	1.52	2.31	-5.68	0.45	1.62	0.16
2010	0.92	1.22	-4.39	0.19	0.64	0.17
2010	1.92	1.59	-4.20	1.79	1.28	0.10
2012	1.82	2.27	-3.50	1.99	2.65	0.14
2013	1.57	1.82	-3.29	1.72	2.09	0.11
2014	1.45	1.86	-2.51	1.92	2.53	0.09
2015	1.20	1.96	-1.32	2.14	3.29	0.13
2016	1.82	2.35	-1.27	3.10	3.89	0.40
2017	1.68	1.88	-0.58	3.22	3.53	1.00
2018	2.02	2.21	0.60	4.34	4.62	1.83

Notes: This table presents the inflation followed by the Federal Reserve to perform monetary policy, the American output gap, the optimal fund rate based on a Taylor's rule supported by Core PCE index (inflation followed by FED), an optimal fund rate based on Taylor's rule supported by the Core Democratic inflation estimated in our study and, lastly, the official funds rates set by FED. Values in percentage.

Figure 15: FED funds rates, Funds Rate with Core PCE and Democratic Core Inflation
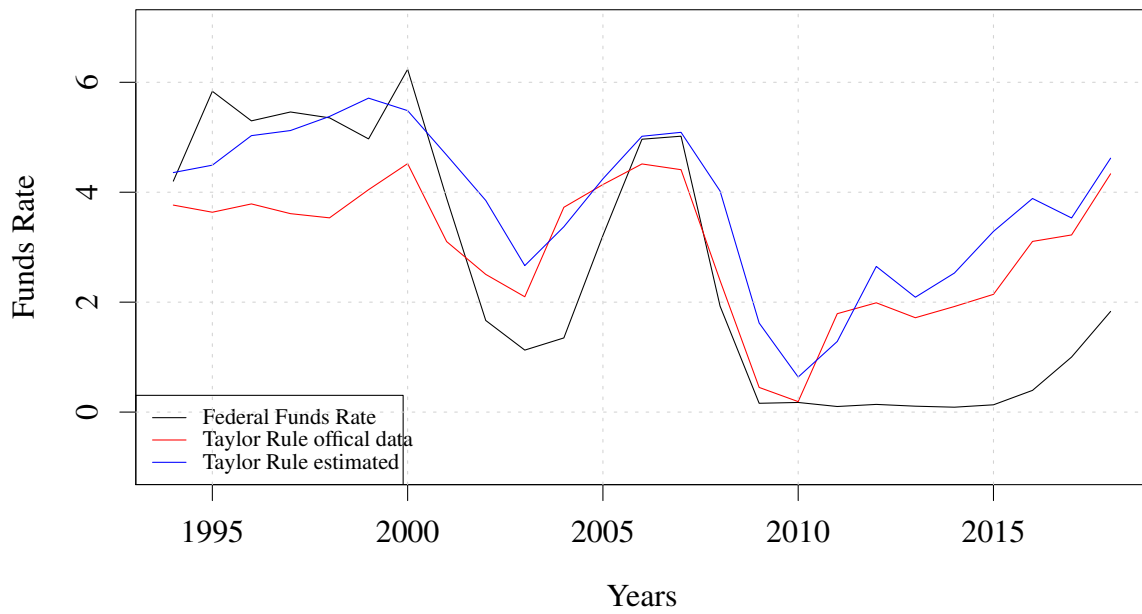
Notes: This image shows the 3 indicators over time. Is notorious the difference between the Taylor's rule's rates and the official FED Funds Rate, between 1994 and 2018.