How Robust are Robust Measures of Inflation?

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Abstract

Time series data for robust inflation measures, such as median and trimmed mean inflation, only start in 1977. We extend these series back to 1960 for Personal Consumption Expenditure (PCE) inflation, providing additional episodes of high and rising inflation to evaluate the series' performance and compare them to headline and core inflation. We find that robust inflation measures tend to diverge in periods of low inflation, but agree when headline inflation is high. When assessing the robustness of the measures, we find that variation in the number of PCE expenditure categories used in calculation and trim points for trimmed means do not have significant effects. In contrast, using yearly instead of monthly chaining of indexes produces markedly different time series. We then compare the performance of 61 robust inflation measures in predicting trend inflation. Trimmed mean measures using yearly chaining perform best overall, while core inflation performs well when inflation is low, and median inflation consistently underperforms.

JEL: E3, E5, E6

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1 Introduction

The return of inflation has characterized the post-pandemic recovery of the US and economies worldwide. It has been accompanied by notable spikes in individual components of the consumption basket. In face of such spikes, policymakers pay particular attention to robust measures of inflation to capture the essence of increases in the movement of prices of goods and services over time. However, the behavior of these robust measures in high inflation regimes is hard to gauge because official releases of the series start in 1977, covering only one episode of high inflation. We therefore study the behavior of the three most commonly used robust measures of inflation—core, median and mean inflation measures—and evaluate their robustness over a longer sample, from 1960 through 2022.

In doing so, our analysis makes three contributions: First, we compute time series of these robust measures going back to 1960. This computation extends the data available for policy analysis back in time to include two further periods of high inflation. We find that the robust measures tend to diverge in periods of low inflation, but agree when headline inflation is high. Second, when assessing the robustness of the measures, variation in the number of series used in calculation and trim points (for the trimmed means) turn out not to have significant effects. However, yearly instead of monthly chaining of indexes produces markedly different time series. Third, we evaluate the predictive performance of the robust inflation measures along with 58 alternative measures that we construct when assessing the robustness of the measures. We find that trimmed mean inflation series computed using yearly inflation indexes outperform other series,[1] with the exception of core inflation during periods of low inflation.

Fundamental to our analysis is the construction of long inflation series for two robust measures of inflation – trimmed mean and median inflation – back to 1960. These measures

[1] Official median and trimmed mean measures operate directly on monthly price changes of individual expenditure categories. On the other hand, "yearly" inflation indexes average the price changes of individual series across twelve months before applying the median or trimmed mean methodology.

are currently only available back until 1977. To construct the extended series, we use the underlying the Personal Consumption Expenditure (PCE) data release from the Bureau of Economic Analysis (BEA). Following the methodologies of the Federal Reserve Banks of Dallas and Cleveland, we replicate their indices post-1977 precisely. The resulting new series are nearly 40 percent longer than the official 1977-2022 sample. Importantly, they cover a total of 122 months of high inflation, 44 of which were previously not covered by the available robust inflation measures.

Based on these extended data, we find that these robust measures of inflation are not very robust. First, the behavior of the three robust inflation measures depends systematically on the level of headline inflation. The different measures provide a consistent signal during times of high inflation, but are often in conflict in periods of low inflation when they diverge. For instance, the range between the lowest and highest inflation measure is 0.8 percentage points on average when headline inflation is below 2.5 percent, but is 0.55 percentage points when headline inflation is above 5 percent. The same patterns hold when we examine the share of variation explained by the first principal component of the three series. This share is 82 percent when inflation is below 2.5 percent and 97 percent when inflation is above 5 percent.

The role of high and low inflation regimes is also important for the variability of the three robust measures of inflation. Overall, the robust inflation measures are less volatile than headline inflation. However, when inflation is below 2.5 percent, median and trimmed mean inflation are more volatile than headline inflation. Likewise, when inflation is between 2.5 and 5 percent, all three robust inflation measures are more variable than headline inflation. Similar patterns appear when we normalize the series by their standard deviations and consider the coefficients of variation. Then, median inflation is the most volatile series when inflation is low (below 2.5 percent), while trimmed inflation is the most volatile when inflation is high (above 5 percent).

Second, we show that the robust measures of inflation we consider are robust along some

dimensions, but not others. Two such dimensions concern the sets of underlying inflation series used and the frequency at which the underlying inflation series are computed. We consider alternative series that vary the sets of categories, and we base the computation of the series on yearly changes rather than monthly chaining of indexes as in the baseline median and trimmed mean series.

We find that computing the series using yearly indexes produces markedly different results, while changing the sets of expenditure categories considered has small effects on the level and behavior of the resulting inflation series. The mean absolute deviation between the baseline monthly chained index and the yearly median inflation is 0.33 percentage points and is 0.28 percentage points for trimmed mean inflation. In comparison, changing the set of expenditure categories leads to mean absolute differences with the baseline measures at most 0.18 percentage points for median inflation and 0.14 percentage points for trimmed mean inflation.

We also consider alternative trimming cutoffs for computing trimmed mean inflation that expand, contract, or skew the set of expenditures categories being used. We find that expanding or contracting the trimming cutoffs has very limited effects. The mean absolute deviation with respect to the baseline trimmed mean measure is at most 0.08 percentage points. Skewed cutoffs, favoring either lower or higher inflation series have a larger effect. We find that these skewed cutoffs can improve the predictive performance of trimmed mean inflation for different time periods where inflation is accelerating or coming down, but they do not perform well systematically.

Finally, we use all the 61 robust inflation measures we compute and test their predictive performance. These 61 series include the official measures of core, median, and trimmed mean inflation, along with the 5 variations on median inflation and 54 variations on trimmed mean inflation we described above. We follow the methodology in Dolmas (2005) and evaluate the series against two measures of trend inflation (a centered 36 month moving average and a forward 24 month moving average of headline inflation). We rank our inflation

measures with respect to their ability to match trend inflation.

We find that core inflation is only the 22nd best measure on average over the entire sample, while the official median and trimmed mean measures perform worse coming in 52nd and 47th place. The higher rank of core inflation comes from its performance in low-inflation periods when it ranks first, outperforming all other measures. In periods of high inflation median inflation performs the best of the official measures. Despite this, it is variations of trimmed mean inflation computed using yearly inflation indexes that are consistently ranked at the top across all periods we consider. Using yearly weights appears to further help robust measures ignore idiosyncratic shocks by smoothing the inflation rate of individual series over 12 months.

We contribute to a large literature that has focused on which measures of inflation provide the best signal about the underlying inflation trend. We add to this literature by extending robust inflation measures to periods of high inflation and focusing on the performance of robust measures during these periods. Related work has focused on the forecasting properties of different series, but has used samples in which inflation has been low most of the time (see, e.g., Dolmas, 2005; Rich and Steindel, 2007; Crane, Khettry, Mester, and Novak, 2013). Other robust measures of inflation have been proposed such as median inflation excluding owners equivalent rent (Carroll and Verbrugge, 2019) and CPI excluding the eight most volatile components (Clark, 2001).

2 PCE Inflation Data

We construct long time series for a variety of U.S. inflation measures covering 1960 to 2022. The primary data for this project come from the underlying data supplements of the National Income and Product Accounts Personal Consumption Expenditure (PCE) data release (Bureau of Economic Analysis, 2022). The PCE data provide highly disaggregated price indexes and expenditure weights that cover U.S. consumer spending. We use data

from January of 1959 to March of 2022. The BEA attempts to construct series under a consistent methodology by revising series when methods change. Based on these series, we compute trimmed mean and median PCE inflation for the period 1960 and 1977, extending the number of months in the sample by almost 40 percent relative to the currently available series.

Several issues accompany the series extension, such as infrequent updates of series, splits or combinations of series, as well as the introduction of new series. The first issue relates to the treatment of infrequent adjustments of some series: Before 1970, the price series for multiple expenditure categories were not updated on a monthly basis, including owner's equivalent rent, the category with the highest weight. Thus, measures of monthly inflation rates contain multiple series with zero inflation in a month. This issue is mostly reflected in the median inflation series as we show in the next section, see Figure 1. We therefore provide alternative series constructed using yearly price changes in Section 4. These measures partially overcome the limitations introduced by infrequent updates.

Another issue that arises when constructing long inflation series is that the number of expenditure categories covered by the PCE data releases varies over time as categories are split or combined and new categories are introduced. When categories split or are combined it is necessary to impose assumptions over the weights of individuals series going backwards or forwards according to the case. This can be done in multiple ways, leading to some of the differences between the robust measures of inflation. We will discuss these differences further in section 4.

Finally, when new expenditure categories are introduced they often have almost zero spending, reflecting the fact that they represent new goods. In those cases, we assume that the goods they represent were not available before their introduction in the PCE, assigning them a weight of zero retroactively. For example, the starting point of 1977 for the median and trimmed mean inflation measures was chosen because this is the first year computers are included in the PCE data. At that time, computers did not have a significant impact

on the price indexes. They accounted for 6 million dollars of (nominal) expenditure out of a total expenditure of 1.2 trillion or 0.0005 percent of consumer spending. Although, the increasing of importance of computers and other technology may have lead to different trends in inflation as documented in Karabarbounis and Neiman (2014).

2.1 Headline and Core PCE Inflation

Our series of headline and core PCE inflation are taken directly from the tables published by the BEA.[2] Headline inflation is calculated as a Fisher index of the underlying inflation components at the lowest level of aggregation. A Fisher index is the geometric mean of a Laspeyres and Paasche index which are calculated respectively as:

$$\pi_t^L = \frac{\sum_i q_{t-1}^i p_t^i}{\sum_i q_{t-1}^i p_{t-1}^i}; \quad \pi_t^P = \frac{\sum_i q_t^i p_t^i}{\sum_i q_t^i p_{t-1}^i}, \tag{1}$$

where p_t^i and q_t^i are, respectively, the price level and quantity of expenditure category i at time t. Core inflation is computed in the same way but excludes all series under "food and beverages purchased for off-premises consumption," "gasoline and other energy goods," and "electricity and gas."

2.2 Trimmed Mean PCE Inflation

Trimmed mean PCE inflation is published monthly by the Federal Reserve Bank of Dallas (Dolmas, 2005) and is available from 1977 onwards (Federal Reserve Bank of Dallas, 2021). It is computed using 177 expenditure categories from the PCE data. The series is constructed by combining the one month inflation rates for a selected sample of expenditure categories that changes every month. The sample is selected by removing the categories with the lowest inflation rates accounting for α percent of expenditure and the categories with the highest inflation rates accounting for β percent of expenditure. The

[2]We use series DPCERG for headline inflation and series DPCCRG for core inflation, obtained from https://apps.bea.gov/national/Release/XLS/Underlying/Section2All_xls.xlsx.

remaining categories are assigned weights using an average of the expenditure on each category at current period quantities and previous period quantities, which approximates the weights used in the PCE index formula:

$$\omega_t^i = \frac{1}{2}\frac{p_{t-1}^i q_{t-1}^i}{\sum_i p_{t-1}^i q_{t-1}^i} + \frac{1}{2}\frac{p_{t-1}^i q_t^i}{\sum_i p_t^i q_t^i}. \tag{2}$$

The trimmed mean PCE inflation series corresponds to the expenditure-weighted mean across the selected categories, where the weights of the series in the endpoints are adjusted so that expenditure accounting for $\alpha + \beta$ percent is removed from the mean. Once the one monthly rates, $\pi_t^{tm,mo}$, are constructed they are chained to form a price index which is used for the published statistics:

$$\pi_t^{tm} = \prod_{s=0}^{11} \pi_{t-s}^{tm,mo}, \quad \pi_t^{tm,mo} = \sum_i \omega_t^i \frac{p_t^i}{p_{t-1}^i}. \tag{3}$$

2.3 Median PCE Inflation

Median PCE Inflation is published monthly by the Federal Reserve Bank of Cleveland (Bryan and Pike, 1991) and is available from 1977 onwards (Federal Reserve Bank of Cleveland, 2021). It is computed using 200 inflation series, 171 of which are also used for computing trimmed mean inflation.[3] The differences include using home health care, medical laboratories, and other professional medical services in place of paramedical services and using more detailed series on audio-video, photographic, and information processing equipment services.

The median inflation series is constructed by selecting in each month the monthly inflation rate such that half of consumer spending in on expenditure categories with (weakly) higher rates of inflation and half of consumer spending is on expenditure categories with (weakly) lower rates of inflation. These monthly rates are then chained

[3]The complete list of series included in each inflation measure can be found in http://dominic-smith.com/data/category_definitions.xlsx.

together to construct a time series of median PCE inflation:

$$\pi_t^m = \prod_{s=0}^{11} \frac{p_{t-s}^{i(m,t-s)}}{p_{t-s-1}^{i(m,t-s)}}, \tag{4}$$

where $i(m, t-s)$ is the index of the series with the median inflation at time $t-s$.

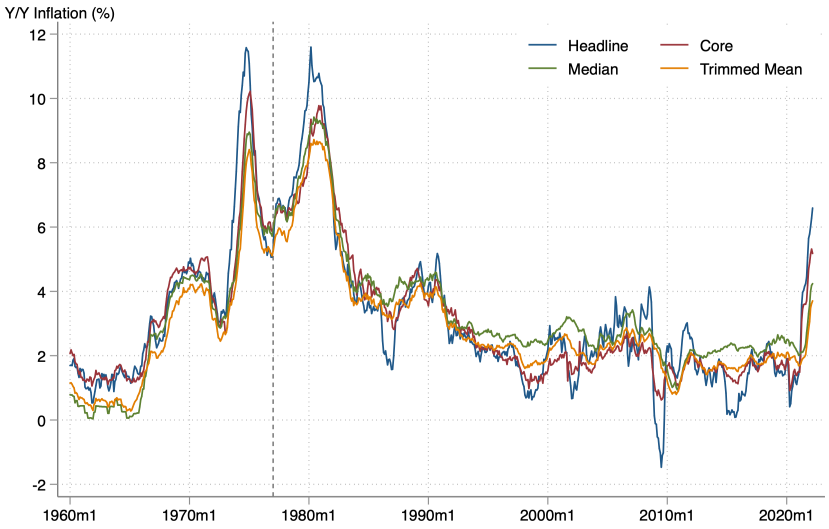
3 Long Series for Robust Inflation Measures

We compute long series for headline, core, median, and trimmed mean PCE inflation beginning in January of 1960 and ending in March of 2022, in doing so we extend the median and trimmed mean inflation series to the 1960-1977 period. Figure 1 plots the series. The headline and core PCE inflation are taken directly from the Personal Consumption Expenditure Price Indexes (Bureau of Economic Analysis, 2022). Median and trimmed mean PCE inflation match the definitions provided by the Federal Reserve Banks of Cleveland and Dallas respectively, extended as shown in Appendix A. As expected, all the robust inflation series track headline inflation and each other but differ in their variability. We explore the differences between these series below.

Extending the series of robust inflation measures to the 1960-1977 period allows us to provide a more consistent view of the patterns of the different robust inflation measures in periods of rising and high inflation, as well as periods of stable and low inflation. The 1960-1977 period provides us with two additional episodes of rising inflation (1968 and 1973), the latter one of which with headline inflation rising above 5 percentage points. This complements the four episodes of rising inflation episodes in the post 1977 period, one of which is at the end of the sample. Importantly, there are only three episodes between 1960 and 2022 for which inflation is above 5 percentage points covering a total of 122 months, 44 of which are in the 1960-1977 period and 6 at the end of the sample. The beginning of the sample also provides us with an additional episode of low and stable inflation.

The different inflation series generally move together and track headline PCE inflation.

Figure 1: Robust Measures of Inflation 1960-2022



Notes: The figure shows the authors' calculations of trimmed mean PCE and median PCE using the methodologies of Federal Reserve Bank of Cleveland (2021) and Federal Reserve Bank of Dallas (2021). See Appendix A for a description of the differences between these measures and the measures produced by the relevant Federal Reserve Banks. The vertical line in January of 1977 indicates that the official trimmed mean and median measures are available starting in 1977. Headline and core inflation are taken directly from the PCE data.

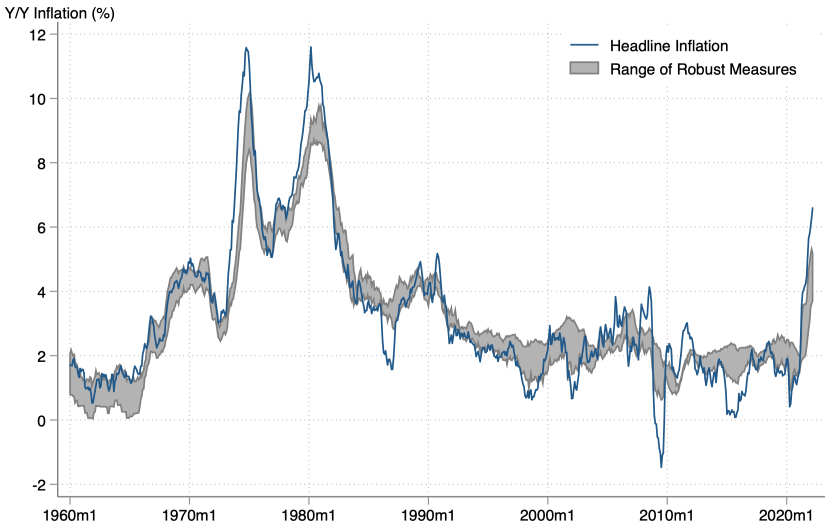
Nevertheless, the series are not always in agreement.[4] In the early periods, median inflation tends to run below the other measures while it has generally been higher since 1990. Core and trimmed mean look similar after 1990 and particularly in the five years following the Great Recession, but in the extended sample it is clear they have larger differences.[5] In fact, there are also consistent differences in the ranking of the robust measures of inflation across time. Core and median inflation have been more likely to be above PCE inflation (53 and 55 percent of months), while trimmed mean inflation has been more likely to be below PCE inflation (56 percent of months).

Now we focus on the performance of these measures in periods with difference levels of

[4]For instance, the sign of the change (whether increasing or decreasing) of core PCE inflation matches that of headline PCE in 65 percent of the months in our sample, the values for median and trimmed mean PCE inflation are 52 and 57 percent, respectively.

[5]The maximum absolute difference between the series is 2 percentage points, achieved in 1975. The difference between the series also increases at the end of the sample, with an average absolute difference of 1.3 percentage points during 2021 and 2022.

Figure 2: Range of Robust Inflation Measures 1960-2022



Notes: The figure shows the authors' calculations of the range of robust inflation measures (core inflation, median inflation, and trimmed mean inflation) from 1960 to 2022. The range is shown in the shaded area. The blue line corresponds to headline inflation.

inflation. There is substantially less agreement between the three robust inflation measures when inflation is low than when inflation is high. In other words, the different measures provide a consistent signal during times of high inflation, but are often in conflict otherwise. Figure 2 shows the range of robust inflation measures for every month along with the level of headline PCE inflation. The range is widest, 0.8 percentage points in average, when inflation is low (less than 2.5 percent), and decreases to 0.6 and 0.55 percentage points when inflation is between 2.5 and 5 percent and when inflation is higher than 5 percent, respectively.

Another way to measure the level of agreement between the series is the share of their variation accounted for by their first principal component. When inflation is below 2.5 percent, the first principal component accounts for 82 percent of the series' variation. This share increases to 94 and 97 percent when inflation is between 2.5 and 5 percent, and when it is above 5 percent respectively. This shows that there is substantial agreement between the signals provided by the different inflation measures when inflation is high.

Table 1: Summary Statistics - Inflation Measures

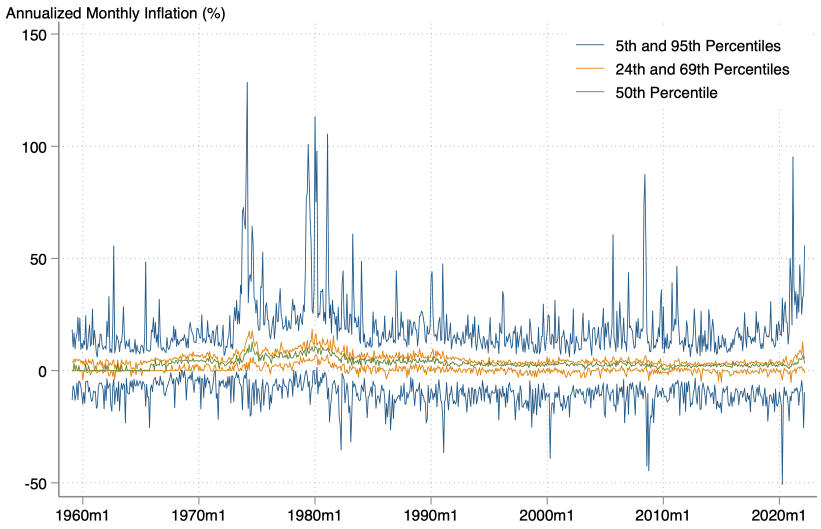
	Inflation Measures			
	Headline	Core	Median	Trimmed Mean
	Full Sample (747 months)			
Mean	3.26	3.21	3.33	2.96
Std. Dev.	2.42	2.13	2.01	1.86
Coeff. Var.	0.74	0.66	0.60	0.63
	$\pi < 2.5\%$ (373 months)			
Mean	1.55	1.73	2.02	1.72
Std. Dev.	0.67	0.53	0.95	0.70
Coeff. Var.	0.43	0.31	0.47	0.41
	$2.5\% \leq \pi < 5\%$ (252 months)			
Mean	3.61	3.51	3.56	3.17
Std. Dev.	0.71	1.07	0.84	0.77
Coeff. Var.	0.20	0.30	0.24	0.24
	$5\% \leq \pi$ (122 months)			
Mean	7.77	7.11	6.88	6.33
Std. Dev.	2.01	1.58	1.58	1.56
Coeff. Var.	0.26	0.22	0.23	0.25

Notes: The numbers are mean, standard deviation, and coefficient of variation of the different inflation measures for different samples determined by the level of PCE inflation. All numbers are in percentage points.

The variability of the robust inflation measures is also higher during low-inflation episodes. Even though the robust inflation measures are overall less volatile than headline inflation, this pattern does not hold throughout the whole sample. Table 1 reports the mean, standard deviation, and coefficient of variation of the four inflation series for different samples that depend on the level of headline inflation, Figure B.1 in Appendix B plots the time series of the standard deviations. When inflation is below 2.5 percent, median and trimmed mean inflation are more volatile than headline inflation, and when inflation is between 2.5 and 5 percent all three robust inflation measures are more variable than headline inflation. Moreover, the coefficient of variation is highest when headline inflation is below 2.5 percent.

The robust inflation measures also change their ranking in terms of how volatile they

Figure 3: Range of Underlying Inflation 1960-2022



Notes: The figure shows the authors' calculations of the range individual inflation series used for different inflation measures from 1960 to 2022. The lines correspond to the 5^{th} and 95^{th} percentiles of the cross section of monthly inflation rates in the 177 series considered for the trimmed mean measure, the 24^{th} and 69^{th} percentiles of the PCE inflation series which correspond to the range used for trimmed mean inflation, and the median inflation series. Percentiles are weighted using the expenditure distribution.

are. Core inflation is the most volatile in the complete sample, but median inflation is more volatile when inflation is low (below 2.5 percent) and trimmed mean inflation is more volatile when inflation is high (above 5 percent).

The main difference between the inflation measures we consider is the underlying range of expenditure categories used to compute them. Figure 3 illustrates this by plotting the range of inflation for the expenditure categories in different measures. The figure shows the 5^{th} and 95^{th} percentiles of the headline inflation series series. Trimmed mean inflation considers expenditure categories that are between the 24^{th} and 69^{th} percentiles. The figure makes it clear that the selection of expenditure categories imposed when computing trimmed mean inflation is meaningful as it substantially reduces the range of inflation being considered. This is even more stark when comparing to median inflation which focuses only on the 50th percentile.

4 Sensitivity of Robust Inflation Measures

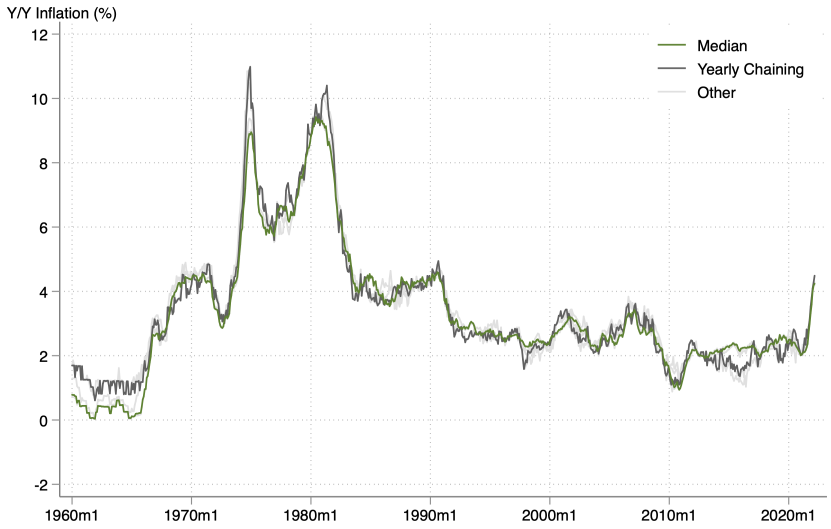
We now show that the robust inflation measures we consider are very sensitive to the ways in which they are computed. There are several measurement choices that can affect the level and behavior of the inflation series, such as the range of underlying expenditure categories taken into account. As Figure 3 shows, the range of inflation of the individual categories that can be taken into account is quite large, and substantial changes can be introduced when restricting this range. There are also methodological choices that can affect the results, such as the use of chained indexes. Below, we focus on the median inflation series and the trimmed mean inflation series and compute variations on their measurement to gauge how sensitive these robust measures are to these choices.

4.1 Median PCE Inflation

Median PCE inflation is calculated using the inflation rate of the expenditure category such that half of consumer spending is on categories with a higher rate of inflation and half is on categories with a lower rate of inflation. The median category is chosen every month and the monthly inflation rate of the median categories is concatenated to get twelve month changes in inflation which make up the median PCE inflation series, see equation (4).

We assess how sensitive the median inflation rate is to two assumptions; the set of expenditure categories used and whether the median is taken on a monthly or yearly basis. The result is five alternative measures of median inflation. We consider three sets of expenditure categories; the 200 categories used for median inflation by the Federal Reserve Bank of Cleveland, the 177 categories used for trimmed mean inflation by the Federal Reserve Bank of Dallas, and the 196 categories used by Schoenle and Smith (2022). The difference between monthly chaining and yearly chaining is whether the median is chosen in each month and then combined to form a yearly rate as in equation (4) or whether twelve month inflation rates are computed and then the median is taken from this distribution,

Figure 4: Sensitivity of Median PCE Inflation 1960-2022



Notes: The figure shows the author's calculations of the median PCE inflation between 1960 and 2022 (green line) together with 5 alternative measures. The first of these measures considers the yearly inflation of the median expenditure category for the same sample of 200 expenditure categories used in the computation of median inflation. This series is presented in dark gray. The remaining series, in light gray, consider alternative samples of expenditure categories (the 177 categories used for computing trimmed mean inflation and the 196 categories used by Schoenle and Smith, 2022) and compute median inflation using chained monthly inflation and yearly inflation.

so that

$$\pi_t^{m_a} = \frac{p_t^{i(m,t)}}{p_{t-12}^{i(m,t)}} - 1, \tag{5}$$

where $i(m,t)$ is the index of the consumption category with the median inflation at time t. Figure 4 shows the results of these calculations.

Most of the differences between the 6 measures of median inflation come from the choice over the chaining of monthly median inflation rates or the use of the yearly inflation rate (shown in dark gray in the figure). The series differ particularly in the levels and timing of the peaks and through of inflation at the beginning and end of the sample, as well as the two peaks in 1977 and 1980. The mean absolute deviation between the monthly chained index and the yearly median inflation is 0.33 percentage points.

Yearly inflation measures give a higher level of median inflation before 1970 because many inflation series were not updated on a monthly basis. This leads to situation were an expenditure category has no price changes across consecutive months but does have price changes across years. After 1970 the two series are closer together, but they differ in the height of the peaks around 1980 and level of inflation in the decade after the Great Recession.

In contrast, we find that the choice over the set of expenditure categories being considered (shown in light gray in the figure) does not have major impacts. This is consistent with the relatively small changes in the number of categories, 200 in the baseline versus 196 and 177 in the alternative measures, all covering most of consumer spending. The mean absolute deviation of these measures with respect to the baseline measure of median inflation is 0.18 and 0.04 percentage points when all series are computed using monthly chained indexes. This is much lower than the difference implied by using yearly inflation shown above.[6] The computation of the median inflation is thus not sensitive to changes in the composition of the underlying inflation series, despite the distribution of inflation across expenditure categories being leptokurtic (Carroll and Verbrugge, 2019), which complicates the computation of various centrality measures.

4.2 Trimmed Mean PCE Inflation

Trimmed mean inflation is calculated by trimming out fixed shares of the highest and lowest rates of inflation in each month. We assess how sensitive the trimmed mean inflation rate is to three assumptions. The first two are the same as in median inflation rate explored above, namely the set of categories used and whether monthly or yearly inflation is considered. The third assumption is specific to the computation of trimmed mean inflation and consists

[6] When we compute median inflation using yearly inflation rates and changing the set of expenditure categories the mean absolute deviation of the series increases to 0.40 and 0.34 percentage points as expected. The mean square errors between the alternative series and the baseline median inflation series show the same patterns.

on the share of spending trimmed out.

The optimal trim shifts over time as shown in (Federal Reserve Bank of Dallas, 2009). The change in the optimal trim could be due to many essentially identical series having slight differences in performance or it can reflect changes in how series with different endpoints perform over time. (Federal Reserve Bank of Dallas, 2009) sets the optimal lower trim at 24 percent and the optimal upper trim at 31 percent, considering data from January of 1977 to June of 2009. We consider lower trims of 19, 24, and 29 percent. We consider upper trims of 36, 31, and 26 percent. We consider all trim combinations including asymmetric trims. This reflects the fact that the current trim used by the Federal Reserve Bank of Dallas is asymmetric and the relevance of changing skewness in the distribution of inflation across time (Dolmas, 2005; Rich, Verbrugge, and Zaman, 2022; Carroll and Verbrugge, 2019; Schoenle and Smith, 2022).

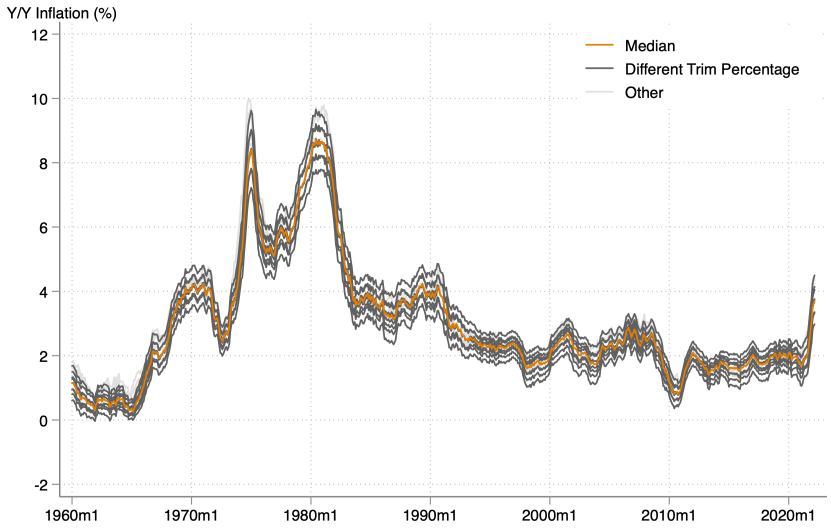
The combinations of trims, underlying expenditure categories inflation series, and the choice over monthly or yearly inflation leaves us with 54 different measures of trimmed mean inflation. We plot 13 of them in Figure 5, corresponding to measures changing only one the deviations we consider at a time.

As with median inflation, the choice over the set of expenditure categories has small effects on the level of trimmed mean inflation throughout the sample while the effects of the choice over monthly of yearly inflation are larger. We show these measures in light gray in the figure. The mean absolute deviation from the baseline trimmed inflation series when changing the set of expenditure categories is at most 0.14 percentage points, while the deviation when using yearly inflation is of at least 0.28 percentage points.[7]

Using yearly inflation series leads to higher levels of trimmed mean inflation throughout most of the sample. However, the differences are smaller than those for median inflation, particularly for the second half of the sample. This comes as no surprise because trimmed

[7]The mean absolute difference between the series can be as high as 0.37 percentage points when changing the set of expenditure categories and using yearly inflation. The same patterns hold for the mean square error although with larger magnitudes.

Figure 5: Sensitivity of Trimmed Mean PCE Inflation 1960-2022



Notes: The figure shows the author's calculations of the trimmed mean PCE inflation between 1960 and 2022 (orange line) together with 13 of the 54 alternative measures. The first set of these measures in dark gray considers changes in the trimming cutoffs keeping the sample of 177 expenditure categories and the chaining of the index used in the computation of the baseline trimmed mean inflation. The remaining series, in light gray, consider alternative samples of expenditure categories (the 200 categories used for computing median inflation and the 196 categories used by Schoenle and Smith, 2022) and compute median inflation using chained monthly inflation and yearly inflation.

mean inflation averages over more series, and is thus less sensitive to individual series behavior (like the one discussed above for monthly inflation series before 1970).

The changes implied by shifting the trimming cutoffs are much larger, we show them in dark gray in the figure. However, expanding or contracting the cutoffs symmetrically does not have a large effect. The mean absolute deviation with respect to the baseline trimmed mean measure when using the widest and narrower cutoffs (19-26 and 29-36 respectively) is at most 0.08 percentage points.[8] Moreover, the series move mostly in tandem regardless of the trimming cutoffs being used, changing the level but not the variation of the series. Overall, the different trimmed mean inflation measures track headline inflation, particularly before 1985. However, none of the combinations picks up the sharp decreases in headline

[8]The deviations are larger when the cutoffs adjust in such a way that they skew the sample towards lower or higher inflation. For instance, when the cutoffs are "low" (19-36) the mean absolute deviation with respect to the baseline trimmed inflation measure is 0.58 percentage points.

inflation in the late 1980s and after the great recession.

5 Evaluating the Performance of Robust Measures

How well do the multiple robust measures of inflation we have computed perform in predicting future inflation movements? To answer this question, we follow the methodology used in Dolmas (2005) to evaluate our 61 different inflation measures. These measures include core inflation, six versions of median inflation and 54 different versions of trimmed mean inflation. We separately calculate results over the entire sample (1960-2022), when inflation is low ($\pi < 2.5\%$), and when inflation is high ($\pi > 5\%$). We find that versions of the trimmed mean which use yearly inflation series generally perform the best, although core inflation performs well when inflation is low. Measures of median inflation consistently under perform both core inflation and trimmed mean.

Our exercise takes place in three steps. First, we create two measures of trend inflation which aim to smooth out the transitory components of inflation. Second, we compare each of our 61 inflation measures to these two trends and calculate the root mean squared error for a given sample (i.e., the full sample, low inflation periods, or high inflation periods). Finally, we describe which series and groups of series perform the best on average.

We consider two measures of trend inflation based on Dolmas (2005). The first measure is a 36 month moving average of headline inflation centered on the current period, $\bar{\pi}_t^{36}$. Thus, it includes 18 previous months of data and 18 future months. The second measure is the forward looking 24 month average rate of inflation, $\bar{\pi}_t^{24}$. We plot these series in Figure B.2 of Appendix B.

Having calculated two measures of trend inflation, we evaluate how well the 61 inflation measures we have constructed track them. We do so by calculating the root mean square

error for each candidate robust measure i as

$$rmse^i = \frac{1}{2}\left(\sqrt{\frac{1}{T}\sum_t(\pi_t^i - \bar{\pi}_t^{36})^2} + \sqrt{\frac{1}{T}\sum_t(\pi_t^i - \bar{\pi}_t^{24})^2}\right). \tag{6}$$

Tables 2 shows the results of the exercise. We find that core inflation is only the 22nd best measure on average over the entire sample. The official median and trimmed mean measures perform worse coming in 52nd and 47th place. The performance of core inflation is entirely due to its performance in periods of low inflation when it outperforms all other measures. In periods of high inflation median inflation performs the best of the official measures.

The lower section of Table 2 also presents the average ranking of different groups of series. Inflation measures using yearly indices outperform those using monthly chained indexes, something to which we return below when discussing the top-ranked inflation measures. Finally, the variations of trimmed mean inflation are on average better than variations of median inflation. This result is also reflected in the top ranked measures we discuss next.

Table 3 shows that the yearly measures of inflation are consistently in the top ranked measures. Over the full sample the top three series all use yearly weights. Using yearly weights appears to further help robust measures ignore idiosyncratic shocks by smoothing the inflation rate of individual series over 12 months. Furthermore, all but one of the top-ranked series are variations of trimmed mean inflation, with the exception of core inflation which is the top-ranked series when inflation in below 2.5 percent. The trimming cutoffs of the top-ranked series are typically the ones used by the Federal Reserve Bank of Dallas or are shifted towards trimming less from the bottom and more from the top. The Schoenle-Smith set of categories consistently appears in the top ranked series. This is somewhat puzzling given the results above that indicate inflation series do not vary substantially with the choice of expenditure categories.

Table 2: Ranking of Various Methods of Calculating Robust Measures

	Average Ranking (out of 61 series)		
	1960-2022	Low Inflation ($\pi < 2.5\%$)	High Inflation ($\pi > 5\%$)
Core Inflation	22	1	42
Official Median Inflation	52	61	22
Official Trimmed Mean Inflation	47	34	50
Average of Yearly Measures	15	17	41
Average of Monthly Measures	46	45	41
Average of Trimmed Mean Measures	31	30	32
Average of Median Measures	41	51	29

Notes: The numbers represent the ranking of various series in terms of mean squared error for different time periods. The first column contains rankings over the entire sample. The second column when inflation is below 2.5 percent over the previous 12 months. The third column contains rankings when inflation is above 5 percent over the previous 12 months. The first three lines contain the performance of the three measures commonly used as robust measures of inflation. The fourth through seventh rows contain the average ranking of the alternative measures we generate by various characteristics. For example, yearly measures takes the average ranking of all measures that are yearly chained, regardless of whether they are trimmed-mean or median or which expenditure group they use.

Table 3: Best Performing Measures by Time Period

Rank	Series Description
	1960-2022
1	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 26$)
2	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 31$)
3	Yearly trimmed-mean with Dallas Categories ($\alpha = 19$, $\beta = 26$)
	Low Inflation ($\pi < 2.5\%$)
1	Core Inflation
2	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 31$)
3	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 36$)
	High Inflation ($\pi > 5\%$)
1	Monthly trimmed-mean with Schoenle-Smith Categories ($\alpha = 29$, $\beta = 26$)
2	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 26$)
3	Yearly trimmed-mean with Schoenle-Smith Categories ($\alpha = 19$, $\beta = 36$)

Notes: The table shows the three best performing series by time period. Yearly measures imply that inflation rates are calculated over 12 months and then trimmed as appropriate, while monthly measures trim separately in each month.

6 Concluding Remarks

We extended two commonly used robust measures of inflation to 1960, significantly increasing their coverage of periods of high inflation. We found that the the behavior of robust inflation measures changes with the level of headline inflation. They are more variable and disagree among them during periods of low inflation, but provide similar signals when inflation is high. We extend our analysis considering variations on the standard robust inflation measures and find that measures constructed using yearly inflation outperform those using monthly chained indexes in predicting trend inflation. Future research might study whether yearly chaining causes robust measures to be unresponsive when inflation is rising or falling, hurting the signal provided by robust measures when inflation regimes may be changing.

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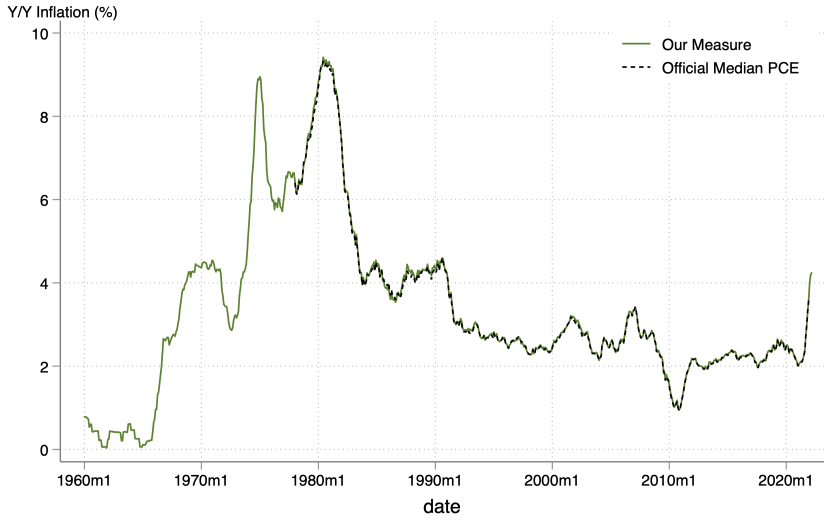
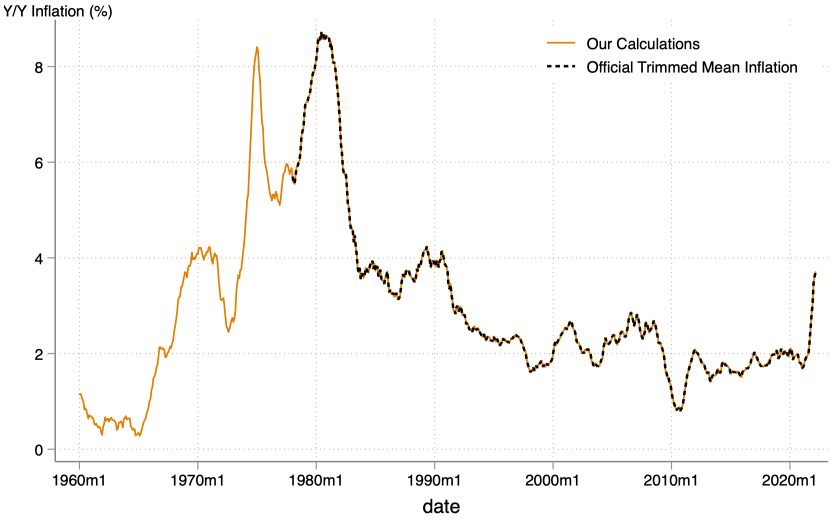
A Replication of Median and Trimmed Mean PCE Inflation

Figure A.1: Replication of Median PCE Inflation 1960-2022



Notes:

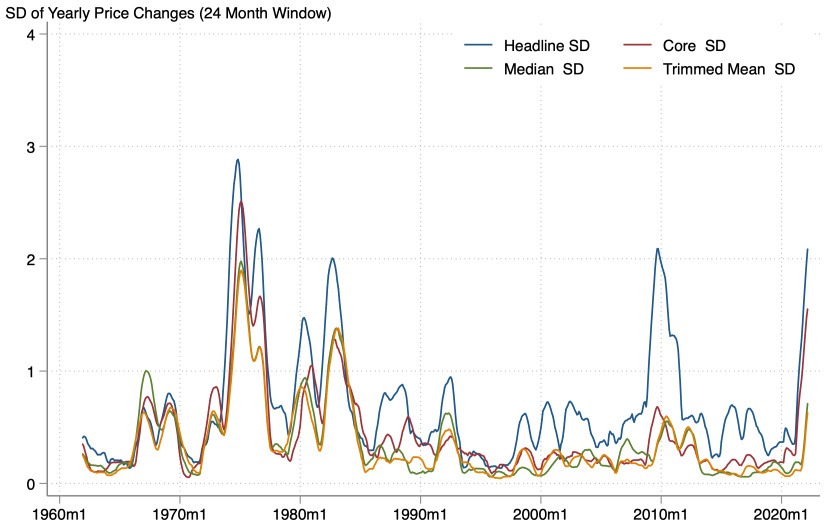
Figure A.2: Replication of Trimmed Mean PCE Inflation 1960-2022



Notes:

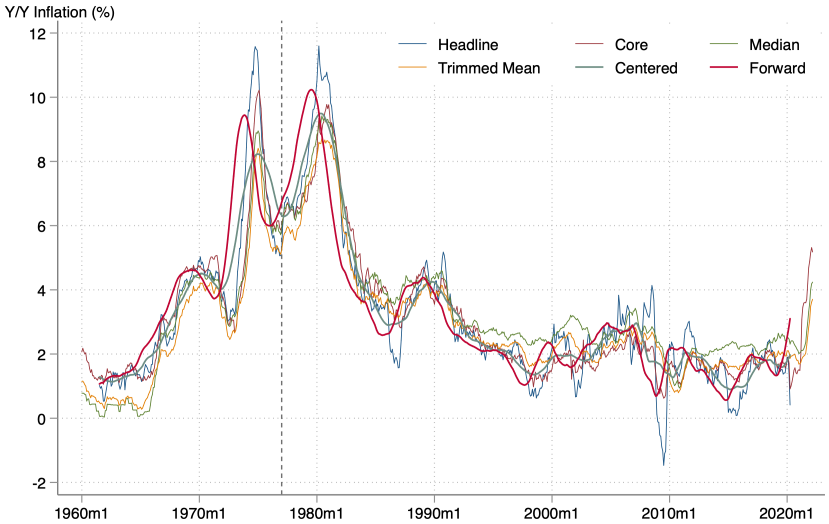
B Additional Figures

Figure B.1: Time Series Variability of Measures of Inflation 1960-2022



Notes: The figure shows the authors' calculations of the standard deviations of headline inflation, core inflation, median inflation and trimmed mean inflation for a rolling window of 24 months.

Figure B.2: Time Series of Trend Inflation



Notes: The figure shows the author's calculations of 36-month centered inflation trend and 24-month forward looking inflation trend with the three main robust measures of inflation and the headline PCE.