How Robust are Robust Measures of PCE 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. We evaluate the robustness of the series along multiple dimensions: First, we find that robust inflation measures tend to diverge in periods of low inflation, but agree when headline inflation is high. The range between the robust measures averages 0.76 percentage points. Second, using yearly instead of monthly inflation when trimming or computing median inflation produces markedly different time series. Third, by contrast, variation in the number of PCE categories used in calculation and trim points for trimmed means do not have significant effects. Finally, we compare the performance of 61 robust inflation measures in predicting (current and future) trend inflation. Trimmed mean measures that trim based on yearly inflation perform best overall, while core inflation performs well when inflation is low, and median inflation consistently underperforms.

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1 Introduction

The return of inflation has characterized the post-pandemic recovery of the U.S. and economies worldwide. It has been accompanied by 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 the 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 before 2020. We therefore study the behavior of the three most commonly used robust measures of inflation—core, trimmed mean, and median inflation—and evaluate their robustness over a longer sample, from 1960 to 2022.

In doing so, our analysis makes three contributions: First, we compute robust measures of inflation going back to 1960 using Personal Consumption Expenditure (PCE) data, the primary data used by the Federal Reserve to evaluate inflation.[1] This computation extends the data available for policy analysis back in time to include two further periods of high inflation. We find that inflation measures tend to differ more during periods of low inflation than when headline inflation is high. Second, using yearly instead of monthly inflation when trimming or computing median inflation produces markedly different time series.[2] Third, we evaluate the predictive performance of the three robust inflation measures along with 58 alternative measures that we construct when assessing robustness. Trimmed mean inflation series that trim PCE categories based on yearly price changes outperform other series.

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 are currently only available back until 1977. To construct the extended series, we use the underlying the PCE data release from the Bureau of Economic Analysis (BEA) and

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[1]These data are available at https://ocamp020.github.io/Robust_Inflation_Series.xlsx.

[2]Official trimmed mean and median measures are computed, respectively, by trimming the highest and lowest monthly inflation or by selecting the median monthly inflation across PCE categories. On the other hand, selecting on yearly inflation indexes averages the price changes of individual expenditure categories across twelve months before applying the trimmed mean or median methodology.

replicate the methodologies of the Federal Reserve Banks of Dallas and Cleveland (see Bryan and Pike, 1991 and Dolmas, 2005). The resulting new series are nearly 40 percent longer than the official 1977-2022 sample. Importantly, they cover a total of 123 months of high inflation (inflation above 5 percent), 44 of which were previously not available.

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 their differences are proportionally higher. Moreover, when inflation is low, median and trimmed mean inflation are more volatile than headline inflation despite being constructed to be less responsive to transitory movements in inflation. In contrast, measures agree when inflation is high because high inflation is generally due to trend shocks and the comovement of prices in the underlying PCE categories (Schoenle and Smith, 2022).

Second, we consider a range of robust measures to explore how sensitive trimmed mean and median inflation are to the way in which they are constructed. We construct alternative measures using three different sets of categories, the 177 used in trimmed mean, the 200 used in median inflation, and a set of 183 that are available throughout the entire sample. We also investigate the impact of applying the trimmed mean or median methodology on yearly rather than monthly inflation series. The distinction between monthly and yearly inflation series is irrelevant when computing headline inflation because it considers all underlying PCE categories without selection, but it matters for trimmed mean and median inflation because different series are dropped each month. Dropping categories based on yearly inflation has the potential to further remove transitory components of inflation at the expense of responding more slowly when inflation is changing. For trimmed mean inflation, we also consider alternative trimming cutoffs that expand, contract, or skew the set of expenditures categories being used.

We find that computing the series using yearly rather than monthly inflation produces markedly different results, while changing the set of expenditure categories or the trimming points (for trimmed mean inflation) has small effects. The mean absolute deviation between the baseline median inflation series and the alternative series based on yearly inflation is .33 percentage points and percentage points for trimmed mean inflation. In comparison, changing the set of expenditure categories leads to mean absolute differences with the baseline measures of at most .06 percentage points, and expanding or contracting the trimming cutoffs leads to mean absolute differences with respect to the baseline trimmed mean inflation measure of at most 0.08 percentage points. Skewed cutoffs, favoring either lower or higher inflation series have a larger effect but bias the resulting series.

Finally, we test the predictive performance of the 61 robust inflation measures we build. These 61 series include the official measures of core, median, and trimmed mean inflation, along with 5 variations on median inflation and 54 variations on trimmed mean inflation. 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, while the official trimmed mean and median measures perform worse, coming in 42nd and 50th place. The higher rank of core inflation comes from its performance in low-inflation periods, when it ranks 12th. Variations of trimmed mean inflation computed using yearly inflation are consistently ranked at the top across all periods we consider. Series based on monthly inflation are more sensitive to transitory changes in prices than those based on yearly inflation. However, series based on monthly inflation are more responsive to changes in inflation trends, making some of them outperform yearly measures when inflation is high. Yearly inflation smoothes out these transitory changes by focusing on the change in prices of each expenditure category over twelve months leading to a better overall performance.

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 the Consumer Price Index (CPI) excluding the eight most volatile components (Clark, 2001). Additionally, the Federal Reserve Bank of Cleveland publishes median CPI and trimmed mean CPI. However, extending these series back in time is of limited use because the headline CPI is not revised when the methodology used to calculate inflation for individual components is changed. Changes in methodology can imply significant changes in the volatility of inflation as shown by Hazell, Herreño, Nakamura, and Steinsson (2022) and Bolhuis, Cramer, and Summers (2022).

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 April of 2022. The main input for BEA price indexes is the Consumer Price Index release, but unlike the CPI the PCE is revised when methods change. Based on these series, we compute trimmed mean and median PCE inflation for the period 1960

to 2022, extending the number of months in the sample by almost 40 percent relative to the official series.

Several issues accompany the series extension, such as infrequent updates of series and the introduction of new series. First, the price series for multiple expenditure categories were not updated on a monthly basis before 1970, 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.[3]

Second, 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 of (nominal) expenditure out of a total expenditure of $1.2 trillion or 0.0005 percent of consumer spending. We establish a set of 183 series that are available either for the entire time period or are available as soon as a new good is introduced and compare the behavior of trimmed mean and median inflation using this consistent set of categories.

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.[4] Headline inflation is calculated as a Fisher index of the underlying inflation

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[3]See Figure B.3 for details on how many series have not have month-to-month price changes over time.
[4]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.

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 multiplying 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 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 yearly inflation 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.[5] 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 to construct an index of yearly 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

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

Figure 1: Robust Measures of Inflation 1960-2022
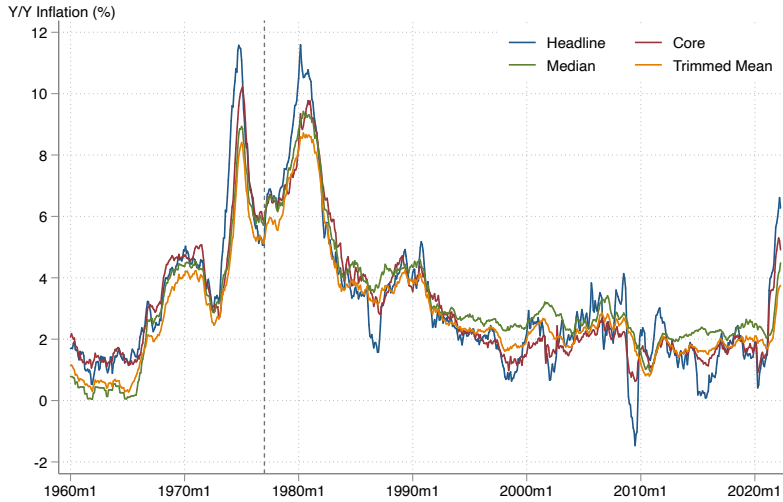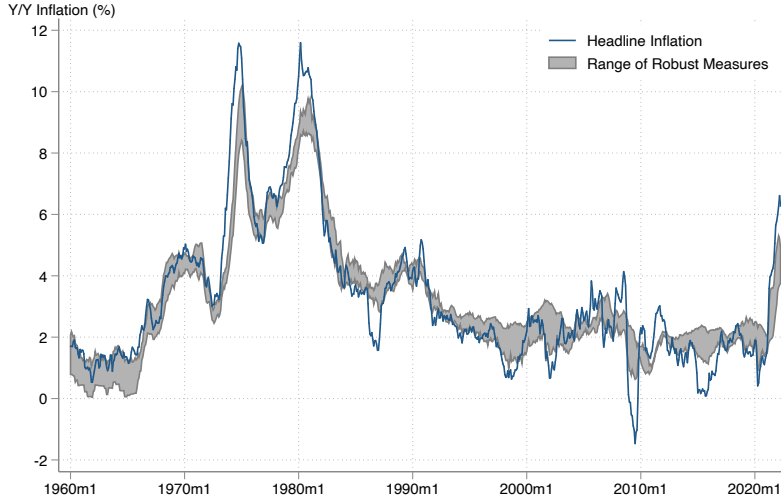

Notes: The figure shows the authors' calculations of trimmed mean PCE and median PCE using the methodologies of Federal Reserve Bank of Cleveland (2021) and Federal Reserve Bank of Dallas (2021). Appendix A shows that these measures exactly match those produced by the relevant Federal Reserve Banks after 1977. 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.

median and trimmed mean inflation series to the 1960-1977 period. Figure 1 plots the series. 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.

In particular, extending the series of robust inflation measures to the 1960-1977 period allows us to provide a more consistent view of the patterns of robust inflation measures in periods of rising and high inflation. The 1960-1977 period provides us with two additional episodes of rising inflation (1968 and 1973). This complements the four episodes of rising inflation in the post-1977 period. Importantly, there are only three episodes between 1960 and 2022 for which inflation is above 5 percentage points, covering a total of 123 months, 44 of which are in the 1960-1977 period and 7 at the end of the sample.

Despite tracking headline PCE inflation, the robust inflation series are not always in

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.

agreement.[6] In fact, there are consistent differences in the ranking of the robust measures of inflation across time. Core and median inflation have mostly been above PCE inflation (53 and 55 percent of months), while trimmed mean inflation has mostly been below PCE inflation (36 percent of months). In the early periods, median inflation tends to run below the other measures while it has generally been higher since 1990. The difference between the series increases at the end of the sample, with an average absolute difference of 1.4 percentage points between 2021 and 2022.

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. We measure agreement with 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

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[6]For instance, the sign of the change (whether increasing or decreasing) of core PCE inflation matches that of headline PCE in 73 percent of the months in our sample, the values for median and trimmed mean PCE inflation are 67 and 74 percent, respectively.

inflation is between 2.5 and 5 percent, and when it is above 5 percent respectively. High inflation is generally due to trend shocks and the comovement of prices in the underlying PCE categories (Schoenle and Smith, 2022), likely making robust inflation series comove as well.

The level of agreement between the series is also captured by the range of values they cover, shown in Figure 2 along with the level of headline PCE inflation. The range is 0.76 percentage points on average over the whole sample, 0.8 percentage points when inflation is less than 2.5 percent, and 0.91 percentage points when inflation is above 5 percent. Thus, the range values covered by robust inflation measures is disproportionately wider when inflation is low than when inflation is high. This again shows that there is substantially more agreement between the signals provided by the different inflation measures when inflation is high.

The variability of the robust inflation measures is also higher during low-inflation episodes despite these measures being constructed to be less responsive to transitory movements in inflation. 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 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).

Table 1: Summary Statistics - Inflation Measures

| | Inflation Measures | | | |
	Headline	Core	Median	Trimmed Mean
	Full Sample (748 months)			
Mean	3.27	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	2.01	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	3.55	3.17
Std. Dev.	0.71	1.06	0.84	0.77
Coeff. Var.	0.20	0.30	0.24	0.24
	$5\% \leq \pi$ (123 months)			
Mean	7.76	7.09	6.85	6.31
Std. Dev.	2.00	1.59	1.60	1.57
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 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 (one-month) inflation for the expenditure categories in different measures. The figure shows the 5th and 95th percentiles of the headline inflation series series. Trimmed mean inflation considers expenditure categories that are between the 24th and 69th 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 effect is even more stark when comparing to median inflation which focuses only on the 50th percentile.

Figure 3: Range of Underlying Inflation 1960-2022
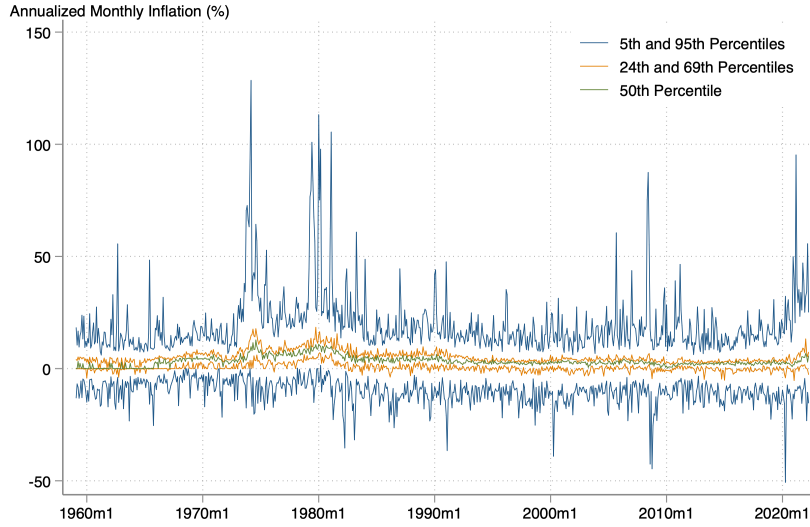
Notes: The figure shows the authors' calculations of the range individual inflation series used for different inflation measures from 1960 to 2022. The lines correspond to the 5th and 95th percentiles of the cross section of monthly inflation rates in the 177 series considered for the trimmed mean measure, the 24th and 69th 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.

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. We focus on the choice of underlying expenditure categories taken into account when computing the series. This choice takes place at two points. The different measures consider different sets of expenditure categories and then select a subset of them every month based on the distribution of monthly inflation rates to compute the respective robust inflation measures. 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 monthly 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 out of a set of 200 expenditure categories. 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 median inflation is to two choices; the set of expenditure categories used and whether the median category is selected based on monthly or yearly 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 183 time-consistent categories described in section 2. When selecting the median inflation based on yearly inflation the median inflation measure is

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

where $i(m,t)$ is the index of the consumption category with the median inflation at time t, rather than the measure presented in equation (4). The result is six measures of median inflation, corresponding to the three sets of categories and the two ways of selecting the median inflation. Figure 4 shows the results of these calculations.

Most of the differences between the 6 measures of median inflation come from whether monthly or yearly inflation indexes are used to select the median inflation. The series based on yearly inflation is 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 official median inflation series and one generated using yearly inflation is .33 percentage

Figure 4: Sensitivity of Median PCE Inflation 1960-2022
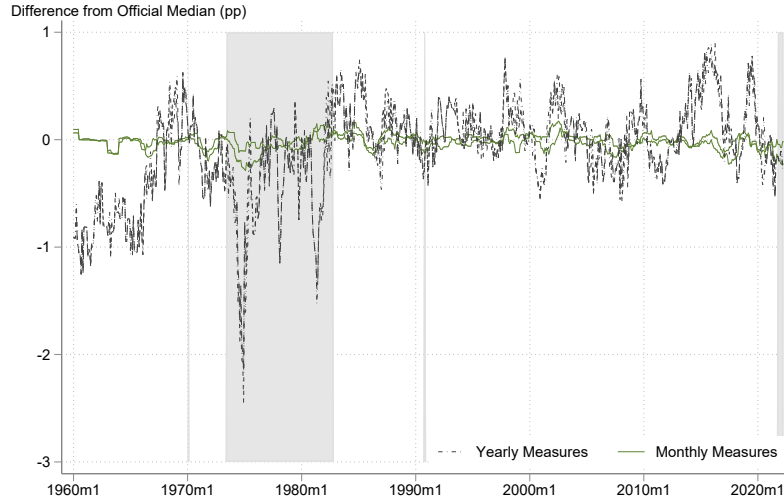
Notes: The figure shows the author's calculations 5 alternative measures of the median PCE. The two measures presented in solid green lines use alternative samples of expenditure categories (the 177 categories used for computing trimmed mean inflation and the 183 time-consistent categories and compute median inflation using monthly inflation. The remaining series use yearly inflation with the three different sets of expenditure categories. The shaded areas represent times that headline PCE exceeds 5 percent per year.

points.

Selecting median inflation based on yearly inflation results in a higher level of median inflation before 1970 because many inflation series were not updated on a monthly basis. This leads to a 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 183 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 0.04 to 0.06 percentage points when all median inflation is

selected based on monthly inflation. This is much lower than the difference implied by selecting based yearly inflation shown above.[7] 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 removing fixed shares of the highest and lowest rates of inflation in each month. We assess how sensitive trimmed mean inflation is to three choices. The first two are the same as in median inflation explored above, namely the underlying set of categories used and whether the selection of the categories is based on monthly or yearly inflation. We additionally study the impact of changing how much is trimmed from the top and bottom of the index.

Federal Reserve Bank of Dallas (2009) found an optimal lower trim of 24 percent and an optimal upper trim of 31 percent, considering data from January of 1977 to June of 2009. However, they also established that the optimal trim shifts over time, implying the optimal trim may change when the series is extended backwards or with the addition of more recent data. 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 of upper and lower trims, implying nine different combinations.

The combinations of trim cutoffs, underlying expenditure categories inflation series, and the selection of trimmed categories based on 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 of the deviations we consider at a time.

As with median inflation, selecting categories based on monthly or yearly inflation has

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[7]When we compute median inflation using yearly inflation and changing the set of expenditure categories the mean absolute deviation of the series increases to .34 and .34 percentage points as expected. The mean square errors between the alternative series and the baseline median inflation series show the same patterns.

Figure 5: Sensitivity of Trimmed Mean PCE Inflation 1960-2022
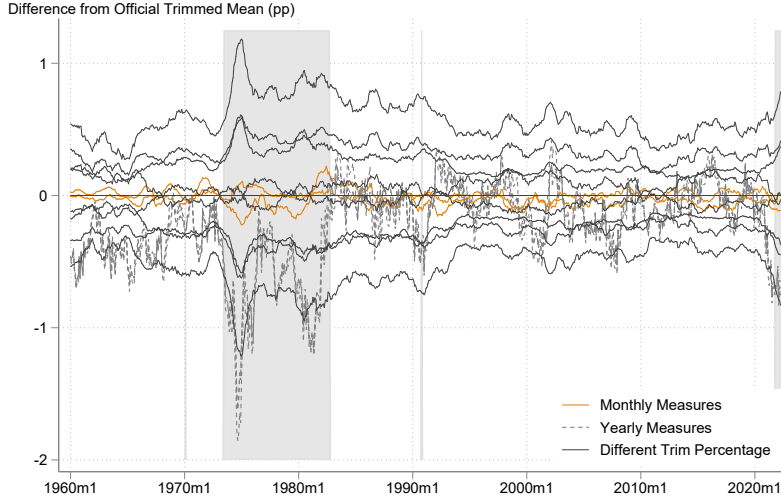
Notes: The figure shows the author's calculations of differences between trimmed mean PCE inflation calculated using alternative definitions and the official measure. The first set of these measures, in orange, considers changes in expenditure categories (the 200 categories used for computing median inflation and the 183 time-consistent categories. The dashing line considers yearly measures with all three expenditure categories. The final set varies the trim cutoffs using monthly inflation with the 177 used in the official trimmed-mean measure. The shaded areas represent times that headline PCE exceeds 5 percent per year.

large effects on the resulting series, while the underlying set of expenditure categories has small effects. We show measures based on different sets of expenditure categories in orange in the figure. The mean absolute deviation from the baseline trimmed inflation series when changing the set of expenditure categories is at most 0.06 percentage points, while the deviation when using yearly inflation is at least 0.28 percentage points.[8]

Trimming based on the distribution of yearly inflation 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 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).

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[8]The mean absolute difference between the series can be as high as 0.30 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.

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. Moreover, the series move mostly in tandem regardless of the trimming cutoffs being used, changing the level but not the variation of the series. 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.

5   Evaluating the Performance of Robust Measures

How well do the multiple robust measures of inflation we have computed perform in matching inflation trends? To answer this question, we follow the methodology used in Dolmas (2005) to evaluate 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 long sample 1970-2022, when inflation is low ($\pi < 2.5\%$), and when inflation is high ($\pi > 5\%$).[9] We find that versions of the trimmed mean which use yearly inflation series perform the best. Measures of median inflation consistently underperform 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.

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[9]We conduct the exercise starting in 1970 to avoid the period at the beginning of the sample in which the price of several PCE categories was not regularly updated.

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.

Given the 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 trimmed mean and median measures perform worse coming in 42nd and 50th place. The performance of core inflation is entirely due to its performance in periods of low inflation. In periods of high inflation median inflation performs the best of the official measures, but it is still well below alternative trimmed mean measures we construct.

The lower section of Table 2 also presents the average ranking of different groups of series. Variations of trimmed mean inflation are better than variations of median inflation across the whole sample and during times of low inflation, with median inflation measures only slightly better when inflation is high. Moreover, inflation measures using yearly inflation outperform those using monthly inflation for both trimmed mean and median inflation, something to which we return below when discussing the top-ranked inflation measures.

Table 3 shows that variations of trimmed mean inflation are consistently the top ranked robust inflation measures, regardless of the level of inflation. Over the full sample the top three series are all constructed using yearly inflation and use same trimming cutoffs.

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	12	41
Official Trimmed Mean Inflation	42	25	49
Official Median Inflation	50	59	22
Ave. of Trimmed Mean Measures	30	29	32
Yearly	15	24	21
Monthly	44	33	42
Ave. of Median Measures	43	56	28
Yearly	35	52	38
Monthly	50	59	18

Notes: The numbers represent the ranking of various series in terms of mean squared error. 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 when inflation is above 5 percent over the previous 12 months. The first three lines contain the performance of the three officail robust inflation measures. The fourth through ninth rows contain the average ranking of the alternative measures. For example, "yearly" takes the average ranking of measures computed using yearly inflation rates.

Using yearly weights appears to further help robust measures ignore idiosyncratic shocks by smoothing the inflation of individual series over 12 months. The cutoffs are 5 percentage points lower than those used by the official trimmed mean measure, leading to a wider range of PCE categories being used. The results are similar when inflation is low, with the exception of the trimming cutoffs of the top series which are now skewed towards categories with lower inflation, as is to be expected.

When inflation is high, two of the three top measures are constructed using monthly inflation. This is because series based on monthly inflation are more sensitive to short run changes in prices than those based on yearly inflation. These changes are often transitory, making robust inflation measures based on yearly inflation more reliable over the whole sample. However, when inflation is rising, monthly inflation reacts more rapidly, making robust inflation measures based on monthly inflation more responsive to changes in inflation

Table 3: Best Performing Measures by Time Period

Rank	Series Description
	1960-2022
1	Yearly trimmed-mean with Dallas Categories ($\alpha = 19$, $\beta = 26$)
2	Yearly trimmed-mean with Time-Consistent Categories ($\alpha = 19$, $\beta = 26$)
3	Yearly trimmed-mean with Cleveland Categories ($\alpha = 19$, $\beta = 26$)
	Low Inflation ($\pi < 2.5\%$)
1	Yearly trimmed-mean with Dallas Categories ($\alpha = 19$, $\beta = 31$)
2	Yearly trimmed-mean with Time-Consistent Categories ($\alpha = 19$, $\beta = 31$)
3	Yearly trimmed-mean with Dallas Categories ($\alpha = 24$, $\beta = 36$)
	High Inflation ($\pi > 5\%$)
1	Monthly trimmed-mean with Time-Consistent Categories ($\alpha = 29$, $\beta = 26$)
2	Yearly trimmed-mean with Time-Consistent Categories ($\alpha = 24$, $\beta = 26$)
3	Monthly trimmed-mean with Cleveland Categories ($\alpha = 29$, $\beta = 26$)

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.

trends. Nevertheless, this behavior is not shared by all monthly series. Table 2 shows that trimmed mean measures based on yearly inflation outperform those based on monthly inflation on average.

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 during periods of low inflation, even when compared to the variability of headline inflation which includes all expenditure categories. This higher variability is reflected in their level of agreement. The series agree substantially more 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 inflation in predicting trend inflation. However, some variations based on monthly inflation

perform well in predicting trend inflation when inflation is high. This is likely due to the higher responsiveness of monthly inflation to changes in inflation when inflation is accelerating, potentially implying that measures based on yearly inflation provide a weaker signal when inflation regimes are changing.

These results highlight the choice over how to select series in the construction of robust measures of inflation. Official series make the selection based on monthly inflation, but selecting based on yearly inflation consistently improves prediction. When computing headline inflation using monthly or yearly inflation is equivalent. That is not the case for trimmed mean and median inflation because using monthly and yearly inflation leads to different categories being selected for the construction of the robust inflation index.

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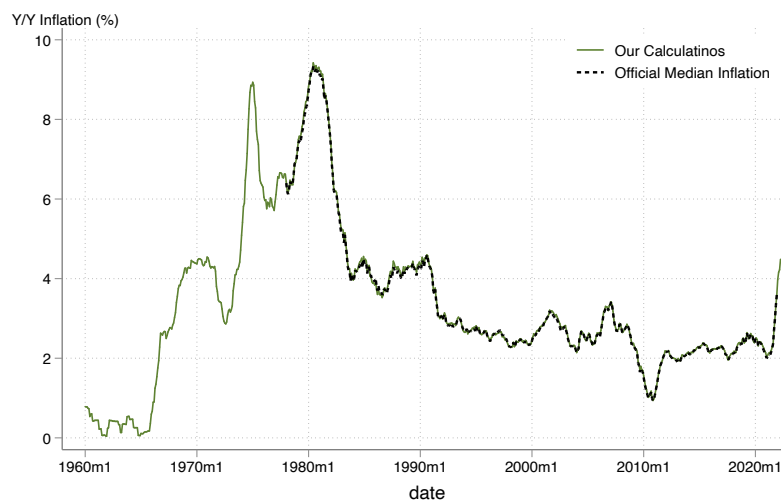
A Replication of Trimmed Mean and Median PCE Inflation

Figure A.1: Replication of Trimmed Mean PCE Inflation 1960-2022
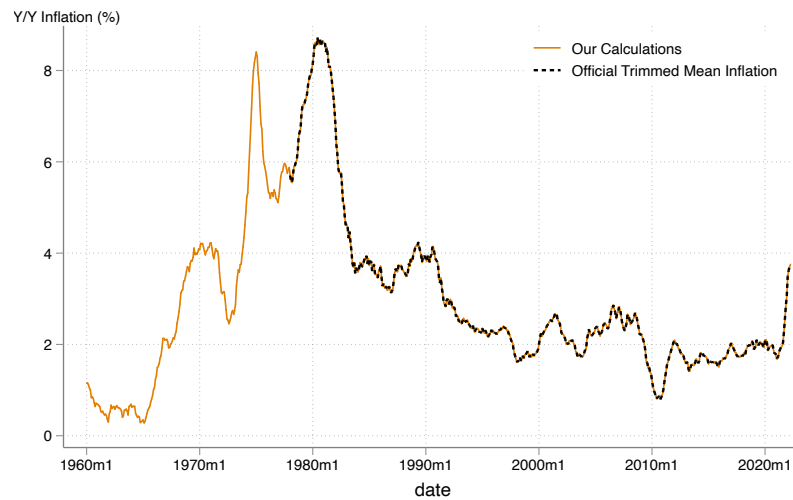
Notes: The figure shows the authors' calculation of Trimmed Mean PCE inflation and overlays the official Trimmed Mean PCE series.
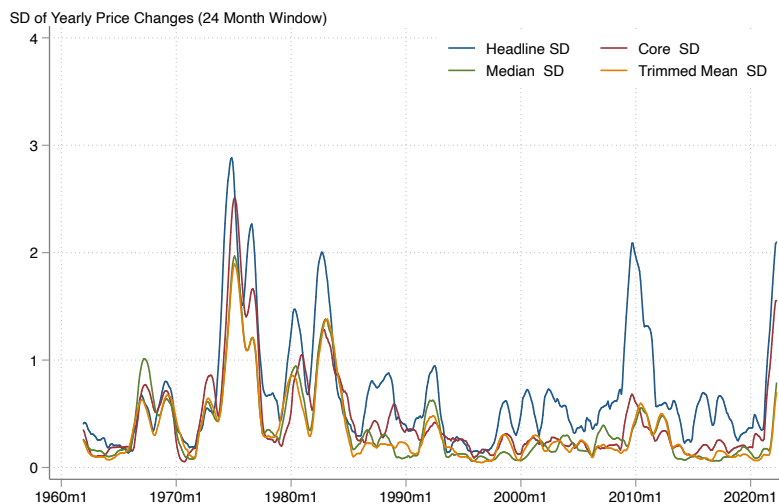
Figure A.2: Replication of Median PCE Inflation 1960-2022

Notes: The figure shows the authors' calculation of Median PCE inflation and overlays the official median PCE series downloaded from FRED.

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.

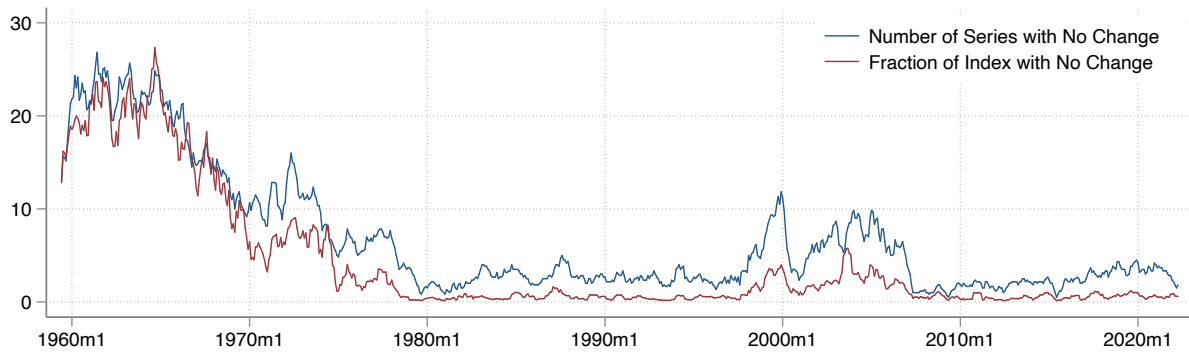Figure B.2: Time Series of Trend Inflation

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.

Figure B.3: Number of Series No Monthly Price Changes
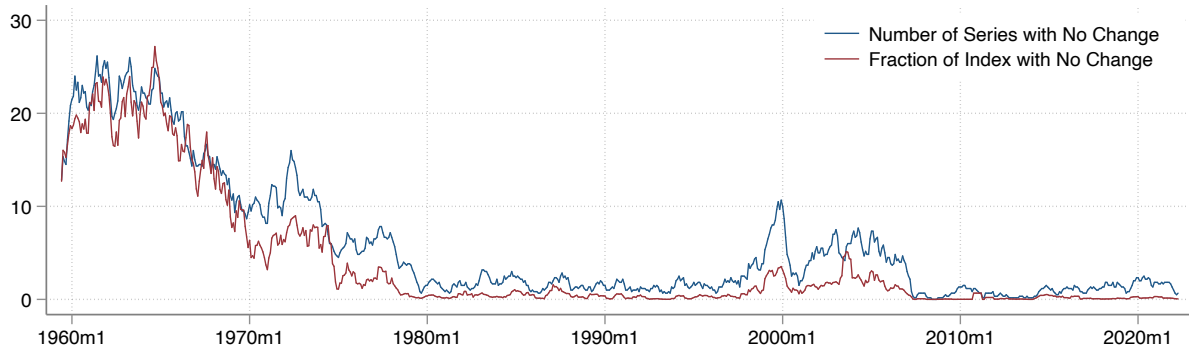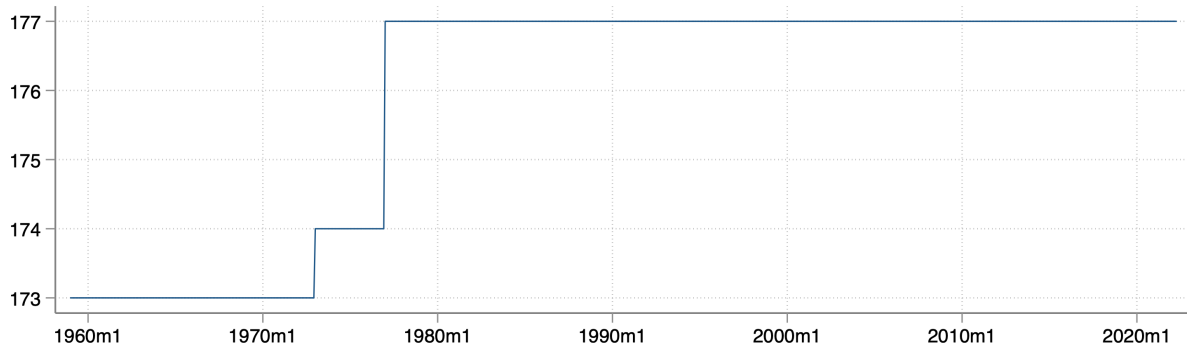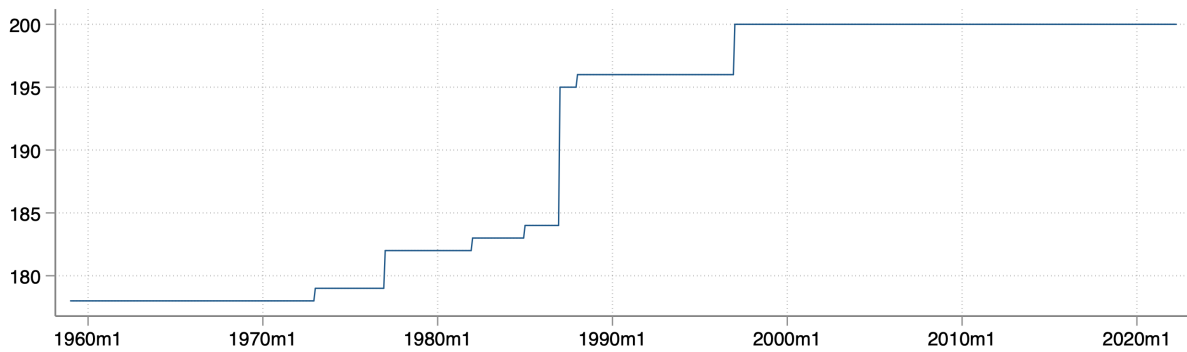

(a) Trimmed Mean

(b) Median
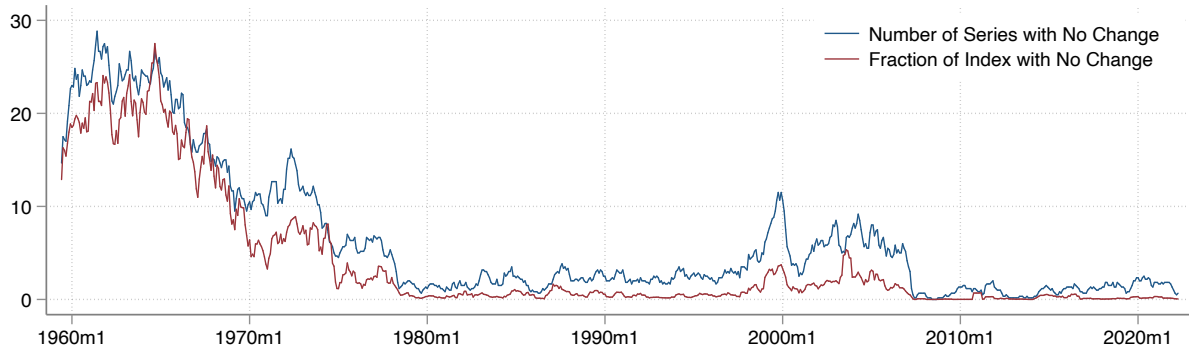
(c) Time Consistent

Notes: The lines plot the number of series and fraction of total expenditure (in percent) with no monthly price change for each of the three sets of series used in the paper.
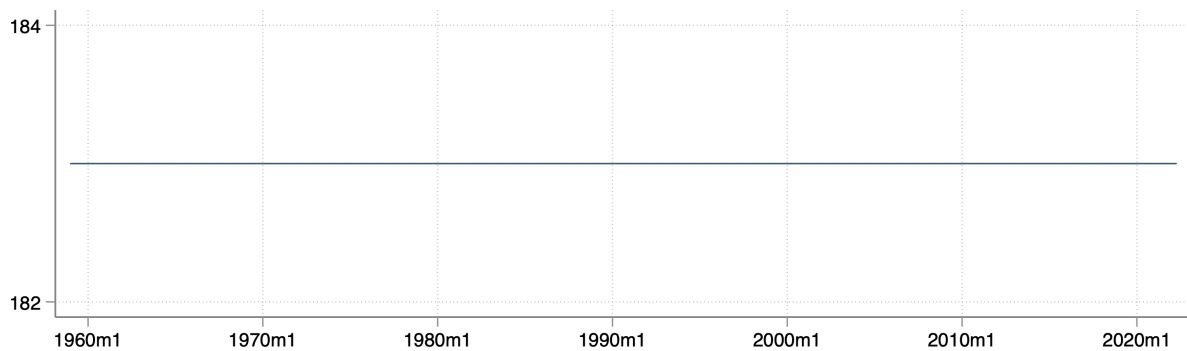
Figure B.4: Number of Series with Positive Expenditure

(a) Trimmed Mean

(b) Median

(c) Time Consistent

Notes: The lines plot the number of series with positive expenditure in the PCE over time from the set of series considered by each of the three sets of series used in the paper.