Detecting Structural Breaks in Inflation Trends: A High-Frequency Approach*

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April 2023

PRELIMINARY DRAFT

Abstract

We combine standard structural-break methods with high-frequency data to identify shifts in inflation trends. We use this approach to study the inflation dynamics of 25 countries from January 2022 to April 2023 and find evidence of a broad-based slowdown. High-frequency data allows us to detect the breaks within a few weeks, whereas CPI data would require months to identify them successfully. We apply single and multiple-break strategies; allowing multiple breaks helps us identify relevant breaks in some sectors but does not significantly change our main results.

JEL-Codes: E31, E37.
Keywords: Prices, Inflation, Structural Breaks, Online Data, Inflation Dynamics.

*We are grateful to seminar participants at CEBRA for their helpful comments and suggestions. Financial Disclosure: Alberto Cavallo is a shareholder of PriceStats LLC, the private company that provided proprietary data used in this paper without any requirements to review the findings.

1 Introduction

Over the past few decades, the economic literature has made significant methodological improvements for detecting structural breaks in macroeconomic time series, including shifts in inflation trends (see Casini and Perron, 2018 for a comprehensive survey). These advances, including dynamic programming algorithms and multiple break tests, have allowed researchers to better identify and estimate breakpoints that are critical for better economic analysis and policy-making. In particular, the improved detection of changes in inflation trends can aid central bankers in implementing more timely and effective monetary policies. However, the low frequency and lags in official Consumer Price Index (CPI) data have tended to limit the application of these techniques for real-time analysis and policy decisions.

In this study, we integrate standard structural-break methodologies with the latest advancements in high-frequency inflation measurement. Our work makes two main contributions. Firstly, we identify the most effective approach to applying structural break tests to the attributes of daily inflation data. Our findings reveal that a straightforward single-break test can identify significant shifts in inflation trends within a matter of weeks. Secondly, we employ this technique to examine the period of high inflation experienced by many countries during the COVID pandemic, providing timely insights into current inflation dynamics.

We rely on high-frequency price indices computed by PriceStats, a private firm that has collected data online from large retailers in over 20 countries for over ten years. The data has several advantages for the identification of inflation trends. First, its daily frequency facilitates the detection of structural breaks over shorter periods of time. Second, the indices are available for highly-disaggregated sectors, allowing us to compute measures that capture the broadness of structural breaks across different goods and services. Third, the data is available in 25 countries in real-time, so we can compare how the changes in inflation trends differed across countries during the recent period of high inflation around the globe (from January 2021 to April 2023).

We first carry out a single-break analysis on the US data. We find a sizable negative break in the aggregate index during June 2022. When analyzing the dynamics of each 1-digit COICOP separately, we find significant heterogeneity in the timing and magnitude of the breaks. The break we detect in the aggregate US series seems to be driven mostly by fuel prices. We then measure the broadness of the structural breaks by analyzing each 3-digit COICOP index separately and computing the cumulative share of CPI weights that experience breaks over time. We find that the share of negative breaks (less inflation) reached 50% in the US in September 2022. By April 2023, this share was already 67%, with only 14% of weights having experienced a positive break (more inflation) at that point in time. Overall, these findings suggest that the US inflation rate had an inflection point around September 2022.

We then extend the analysis to all the countries in our dataset. Although many of them experienced similar inflation dynamics during the first two years of the COVID Pandemic, our results show significant heterogeneity from mid-2022 onwards. In some countries like Argentina and Colombia, inflation is accelerating rapidly, while in other countries like Canada and the US, we

find evidence of a widespread slowdown. Interestingly, we find mixed results within Europe, which suggests that the factors driving inflation in Europe became more country-specific during this period. Overall, about half of the countries in our sample were experiencing inflation slowdowns in April 2023, with a larger share of CPI weights having negative breaks than positive ones. We find less evidence of a slowdown when we focus on core sectors.

To illustrate the advantages of high-frequency data, we compare our main results with those obtained using monthly CPI data. We run a single-break test on equivalent US all-items indices and compare their detection speed, defined as the time it takes to detect a break. With daily data, we can identify the June 2022 break within two weeks using only six months of historical data. With the monthly CPI, we need to wait about three months to detect the same break and use over a year and a half of historical data.

In the last section, we follow a multiple-break approach. The single-break strategy allows us to detect the largest break in each price series. However, some series might experience more than one significant break, and this could affect our findings. To alleviate this concern, we repeat the analysis allowing up to three breaks. Although our main results hold, the multiple-breaks approach helps us to detect more recent changes in the aggregate index and in volatile sectors such as Food and Transportation.

2 Data

We use daily price indices computed using data obtained from large retailers' websites that sell products both online and in brick-and-mortar stores. The data were collected by PriceStats, a private firm related to the Billion Prices Project at Harvard and MIT. Previous research has shown that these indices can closely track official CPI statistics in many countries and often anticipate changes in inflation trends by several months (Cavallo, 2013, and Cavallo and Rigobon, 2016).[1]

The data is available from January 1st, 2022, to April 20th, 2023, for 25 countries: Argentina, Australia, Brazil, Canada, Chile, China, Colombia, France, Germany, Greece, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Poland, Russia, South Africa, Spain, Turkey, UK, Uruguay, and the US. It covers six major CPI sectors (1-digit COICOP) and 76 subsectors (3-digit COICOP). On average, about 60% of official CPI weights are included in each country. The coverage is nearly complete for goods in the CPI basket, but relatively few services are available. In particular, shelter indices (actual and imputed rents) are not included in any of these indices.

Despite their frequency, these daily price indices are often less volatile than monthly official data and tend to display stable inflation trends for many months, which makes it easier to detect structural changes. This is illustrated with Figure 1, where we plot the aggregate price index for the US since the start of the COVID Pandemic. By simply looking at the slope of this graph, we could distinguish some changes in inflation trends: there appears to be an increase in January

[1] See Cavallo (2017) for a comparison of online and brick-and-mortar price levels, and Goolsbee and Klenow (2018) for another comparison of online and traditional retail pricing behaviors.

2021, another in January 2022 and a significant slowdown in mid-2022. In sections 4.1 and 6.2, we confirm the precise date for these changes in the US inflation trend using the structural-break methodology.

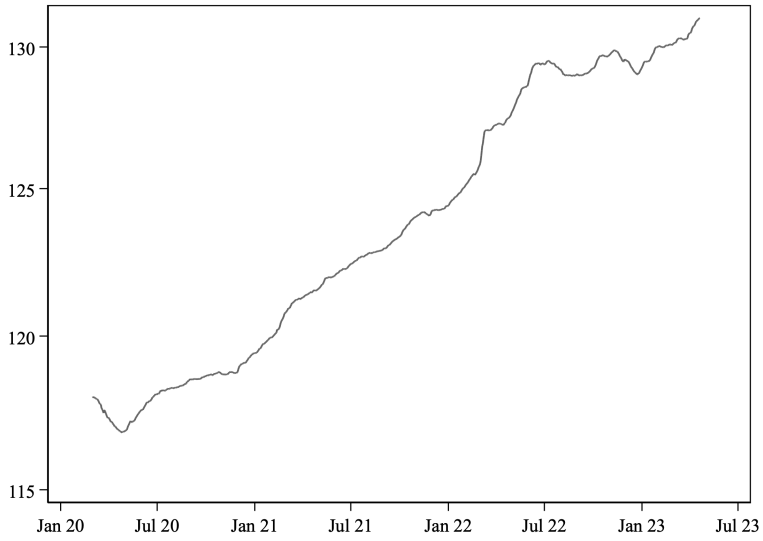


Figure 1: US Aggregate Daily Price Index

Notes: This figure shows the US daily aggregate price index computed from all the sectors covered in the data from January 2020 until April 2023.

3 Empirical strategy

Our goal is to identify the presence and location of recent trend breaks in prices using high-frequency data. For each price series, we propose the following model:

$$Prices_t = \delta_1 + \beta_1 DT_t + \delta_2 I[t > T_b] + \beta_2 DT_t \times I[t > T_b] + \mu_t, \quad t = t_1, ..., T_b, ..., T \tag{1}$$

where $Prices_t$ is the observed price level at time t, DT_t is a deterministic trend, and μ_t is the disturbance. This model allows for a single break at $t = T_b$. Since we are interested in trend breaks (and not in level breaks), we focus on β_2. If $\beta_2 = 0$, there is no trend break. If $\beta_2 \neq 0$, there is a trend break at $t = T_b$. As the breakpoint T_b is unknown, we need to determine its location before testing the significance of β_2.

Estimation. Bai (1997) and Bai and Perron (1998) show that one can consistently estimate the location of a single break using Ordinary Least Squares, even when the true number of breaks is larger than one. However, Yang (2017) argues that this strategy fails in linear trend models. When estimating a single trend break in the presence of various breaks, the estimator does not converge to one of the true dates. Yang (2010) provides a simple solution by showing that taking

first differences solves the inconsistency problem. For this reason, we estimate a first-differences model for each price series:

$$Prices_t - Prices_{t-1} = \alpha_1 + \alpha_2 I[t > T_b] + \mu_t, \quad t = t_1, ..., T_b, ..., T \tag{2}$$

where $Prices_t - Prices_{t-1}$ is the first difference of the observed price level at time t, and μ_t is the disturbance. The estimation method is Ordinary Least Squares. Let $\hat{\alpha_1}(T_j)$ and $\hat{\alpha_2}(T_j)$ be the estimates when the break is assumed to occur at some point $t = T_j$. For each $T_j \in (t_1, T)$, the sum of squared residuals (SSR) is given by:

$$SSR(T_j) = \sum_{t=1}^{T_j} [(Prices_t - Prices_{t-1}) - \hat{\alpha_1}(T_j)]^2 + \sum_{T_j+1}^{T} [(Prices_t - Prices_{t-1}) - \hat{\alpha_1}(T_j) - \hat{\alpha_2}(T_j)]^2 \tag{3}$$

The estimated break point $\hat{T}_b^*$, with the associated parameter estimates $\{\hat{\alpha_1}(\hat{T}_b^*), \hat{\alpha_2}(\hat{T}_b^*)\}$, is the one that produces the minimum SSR. Since $\hat{T}_b^*$ can take a finite number of values in the discrete interval (t_1, T), we can find it by a grid search. To avoid the possibility of estimating a break near the beginning or the end of the series, we set a trimming of 10%. To increase the efficiency of the search process, we use the algorithm developed by Bai and Perron (2003a) based on the principle of dynamic programming.

Inference. Once we find the breakpoint $\hat{T}_b^*$ that produces the minimum SSR, we can test its significance:

$$H_0 : \alpha_2(\hat{T}_b^*) = 0 \quad vs \quad H_A : \alpha_2(\hat{T}_b^*) \neq 0$$

We reject the null if the SSR from the model with a break at $\hat{T}_b^*$ is *sufficiently* smaller than the SSR of the model with no breaks. The asymptotic critical values for a 10% trimming are provided in Bai and Perron (2003b). Since $\hat{T}_b^*$ is the breakpoint that produces the minimum SSR, under the null, we conclude that there is no break at $t = \hat{T}_b^*$ neither at any other date. Under the alternative, we conclude that there is a break at $t = \hat{T}_b^*$.

Multiple breaks. In Section 6.2, we adopt a more flexible approach that allows us to detect multiple breaks. Extending single-break methodology to the context of various breaks is quite straightforward.

Consider the following model:

$$Prices_t - Prices_{t-1} = \alpha_j + \mu_t, \quad t = T_{j-1} + 1, ..., T_j, \tag{4}$$

for $j = 1, ..., m + 1$. This model allows for m breaks (or $m + 1$ regimes). The breakpoints $(T_1, ..., T_m)$ are unknown. Bai (1997) and Bai and Perron (1998) show that we can consistently estimate all the breakpoints sequentially using Ordinary Least Squares. When estimating a single break in the presence of multiple breaks, the estimator converges to the true break fraction T_b^* that

yields the maximum reduction in the SSR compared to the model without breaks. If this reduction in the SSR is *sufficiently* large, we conclude that there is a break at $t = T_b^*$. When estimating a second break, the estimator converges the true break fraction T_b^{**} that produces the second-highest decrease in the SSR. If the SSR of the model with two breaks at $t = T_b^*$ and $t = T_b^{**}$ is significantly smaller than the one of the model with a single break at $t = T_b^*$, we conclude that there are two breaks at $t = T_b^*$ and $t = T_b^{**}$.

Following this logic, we can consistently estimate the presence and location of all the breaks by repeating this procedure until there is no significant reduction in the SSR. In Section 6.2, we follow these steps to detect up to 3 structural breaks.

4 Single-Break Results

In this section, we look for a single structural break since January 2022. We first focus on the US to build intuitions and better explain the statistics we are computing to detect inflection points. We then expand the analysis to all 25 countries in our sample and highlight the differences.

4.1 US Results

Figure 2 shows the estimated trend break in the US aggregate index using the single-break methodology since January 2022. A negative break was detected on June 14th, 2022, indicating that the aggregate inflation rate is experiencing a slowdown.

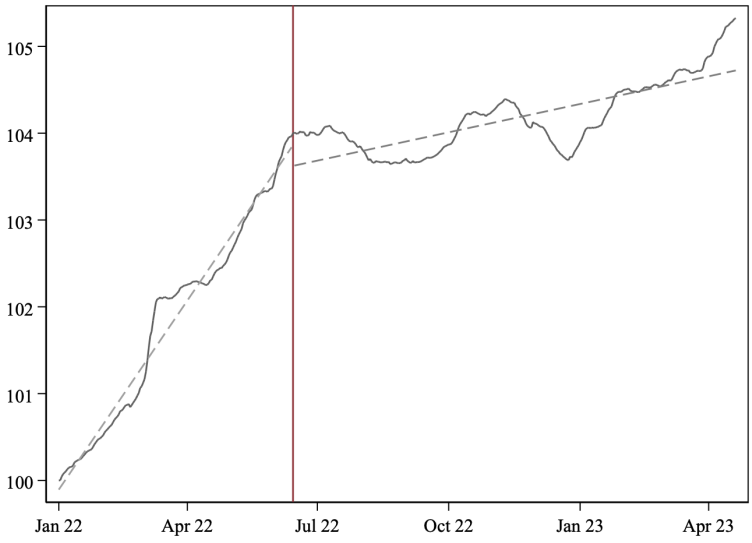
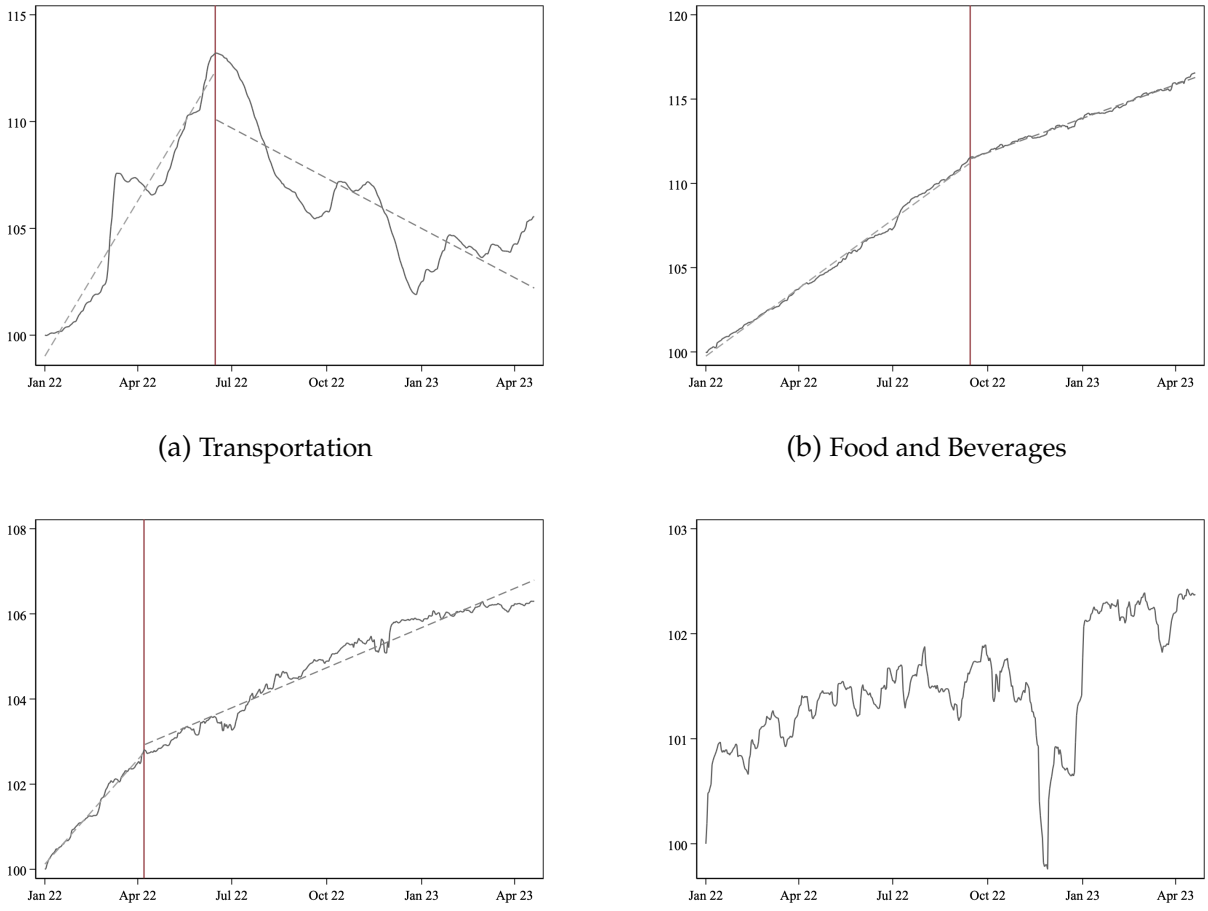


Figure 2: Structural Trend Break - US Aggregate Price Index

Notes: The figure shows the US daily aggregate price index computed with data from all the sectors covered in the data. The red vertical line marks the date of the estimated structural break in the linear trend. Although the graph shows the level of the series, the breakpoint was estimated using the first difference (see Section 3 for details).

To understand what sectors are driving the slowdown in the aggregate inflation rate, in Figure 3 we show the estimated breaks for some relevant 1-digit sectors. Panels (a) and (b) depict the estimated breaks for two of the most volatile headline sectors in the US: “Transportation" and “Food and Beverages". The transportation sector, which is considerably driven by fuel, experienced a large negative structural break on June 15th, 2022. Food also experienced a negative break, but it happened on September 14th and was of a much smaller magnitude (hard to detect by just looking at the graph).



(a) Transportation

(b) Food and Beverages

(c) Household and Furnishings

(d) Electronics

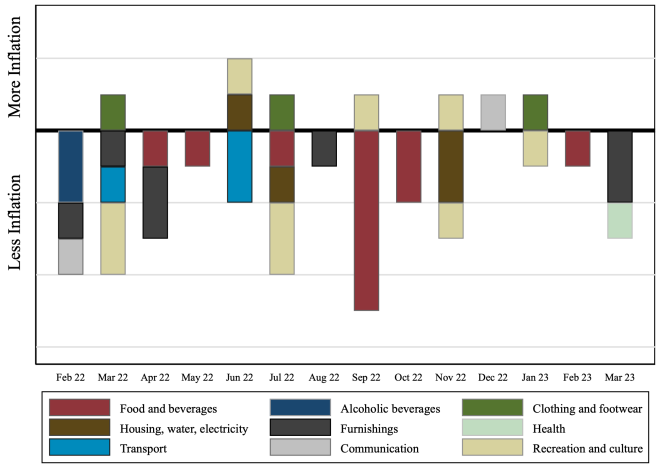
Figure 3: Estimated Structural Trend Breaks in US Sectors

Notes: The figure shows the daily price indices for different US sectors. The red vertical line marks the date of the estimated structural break in the linear trend. Although the graphs show the level of the series, the breakpoints were estimated using the first difference (see Section 3 for details).

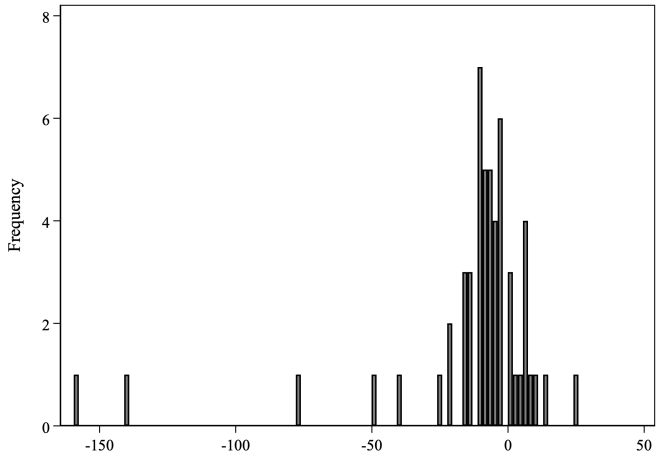
There are also significant differences if we focus on some core goods sectors, as shown in panels (c) and (d). The sector “Household & Furnishings" experienced a small but early break on April 7th, 2022, shortly after the Federal Reserve started to increase interest rates. This might be expected because this sector includes many durable goods, which are presumably more sensitive

to interest rate hikes. By contrast, the “Recreation and Electronics" sector experienced no structural break at all, despite a notable seasonal decline in the price level around the holidays.

A better understanding of the trend changes’ timing, magnitude, and breadth can be obtained by looking at the price indices computed at the more disaggregated 3-digit COICOP level. We estimate the structural trend breaks for each of these indices and summarize the timing and magnitude with the graphs in Figure 4.



(a) Timing of Break - Color by 1-digit Sector



(b) Annualized Trend Change

Figure 4: Estimated Structural Trend Breaks in Dissagregated 3-digit US Sectors

Notes: these figures depict the timing and magnitude of the inflations’ trend changes. Panel (a) shows the timing of the trend changes in all 3-digit COICOP sectors, colored by 1-digit level. Panel (b) shows a histogram of the annualized trend change. To define the annualized trend change, we compute the difference between the trend before and after the break and multiply it by 365.

The differential timing of sectoral inflation breaks can be seen in Panel (a), where we show the

number of subsectors that experienced trend breaks each month. Most subsectors had negative breaks, but there were significant changes in timing. Consistent with the results in Figure 3, the transportation subsectors had negative breaks in March and June, while the food subsectors had most of their breaks during September and October.

The magnitude of these sectoral breaks can be seen in Figure 4b, where we show a histogram of the annualized trend changes in each 3-digit sector, regardless of when they occurred or their weight in the CPI basket. The negative outliers are all energy-related sectors.

Our findings suggest that the structural break we detect in the aggregate US series in Figure 2 is mainly due to fuel prices, which tend to be volatile and temporary. As such, it may not be a reliable indicator of a persistent inflection point in the aggregate inflation dynamics. One way to avoid this concern is to exclude fuel. In Section 6.1, we go further and focus only on Core sectors. The problem with this approach, however, is that it is hard to know *a priori* which sectors should be excluded from the analysis.

To better determine the breadth (and potentially the persistence) of trend breaks, we compute the share of cumulative CPI weights that have experienced both negative and positive trend breaks since January 2022. We use official CPI weights for each category available in our sample and plot the cumulative sum of these weights for sectors experiencing breaks up to each day in Figure 5.

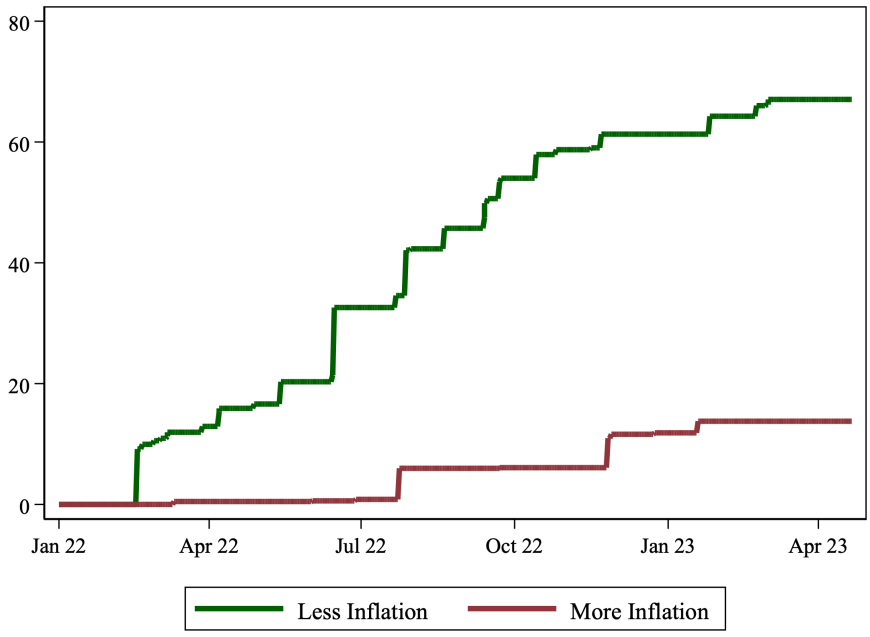


Figure 5: Share (%) of US CPI weights with structural breaks since January 2022

Notes: This figure shows the cumulative share of CPI weights that experienced positive (more inflation) and negative (less inflation) breaks between January 2022 and April 2023.

In principle, if more than 50% of CPI weights are experiencing less inflation (a negative trend break), we can expect the inflation trend to be past its "peak". According to this metric, the in-

flection point for US inflation occurred on September 15th, 2022, three months after the annual CPI inflation rate peaked at 8.9%. Figure 5 also shows a gradual increase in the cumulative share of sectors with more inflation (positive trend break), but this is too small to compensate for the declines.

Between January 2022 and April 2023, approximately 67% of US CPI weights had experienced a negative break, 14% a positive break, and 19% had still no detectable structural change in the inflation trend. Figure 6 repeats this calculation within 1-digit sectors. The vast majority of the sectors with more inflation are concentrated in “Recreation and Culture" and “Clothing", two categories with relatively small weights in the CPI basket. Overall, this evidence suggests that the US was still experiencing a significant and broad slowdown in inflation trends by early 2023.

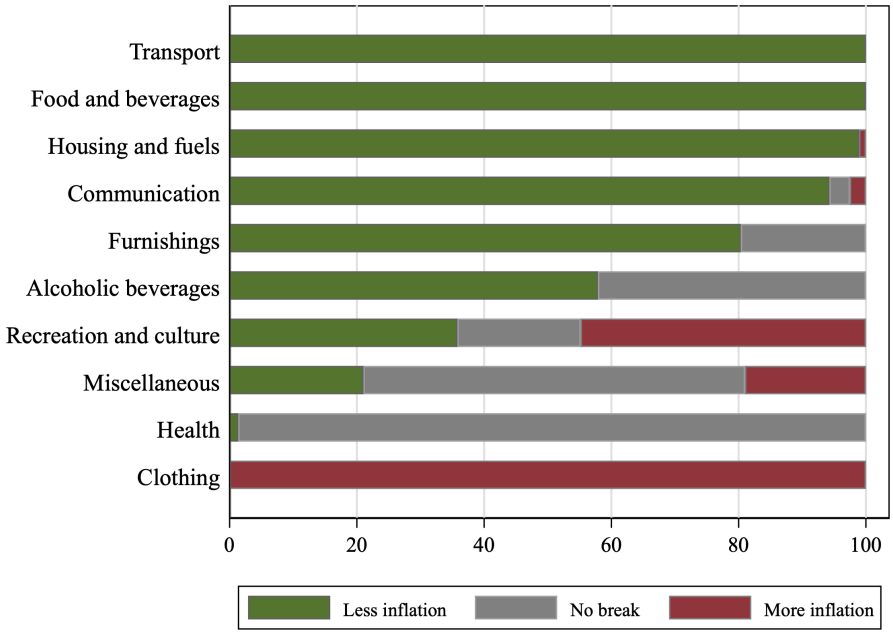


Figure 6: Share (%) of US CPI weights with Breaks by April 2023

Notes: This figure shows, for each 1-digit sector, the share of CPI weights that experienced positive, negative, or no breaks between January 2022 and April 2023.

Starting from a fixed period, such as January 2022, can help describe the inflation dynamics after a major shock. However, as the sample grows, these cumulative shares are less informative about the current path of inflation. To overcome this limitation, we repeat these calculations using a 12-month rolling window. In Figure 7, we show the share of CPI weights that have experienced a speed-up in inflation (positive breaks) and a slowdown in inflation (negative breaks) in the preceding 12 months. We have data from January 2021 onwards, so we can first compute these shares in January 2022.

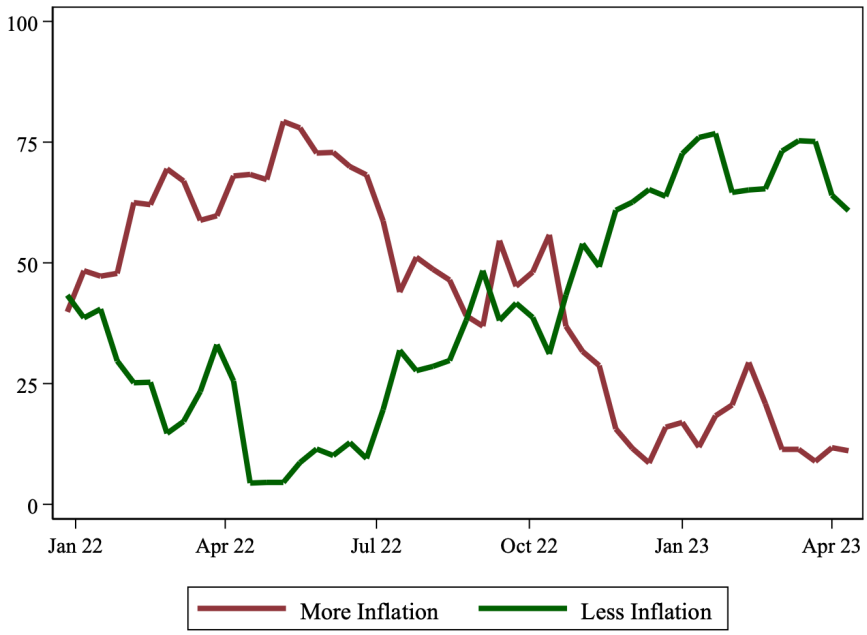


Figure 7: Share (%) of US CPI weights with structural breaks - 12-months Rolling Window

Notes: This figure shows, for each 1-digit sector, the share of CPI weights that experienced positive, negative, or no breaks for each 12-month rolling window between January 2022 and April 2023.

Figure 7 identifies two inflection points for the US inflation trends. The first one occurs in January 2022, when most breaks were positive and rising. This pressure for higher inflation started to recede in May 2022 as more sectors started to experience negative breaks instead. In June, we can detect a trend break for the aggregate index, but the sectoral data suggests the true inflection point happened in September 2022, when the share of weights with negative breaks started to be higher than the share of positive breaks. Figure 7 also suggests the trends were stabilizing by April 2023. At this point in time, 61% of the sectoral weights had experienced a negative break, 11% had a positive break, and 26% had no break in the previous year.

Additionally, we can incorporate the fact that some sectors do not experience breaks by building a diffusion index, shown in Figure 8.

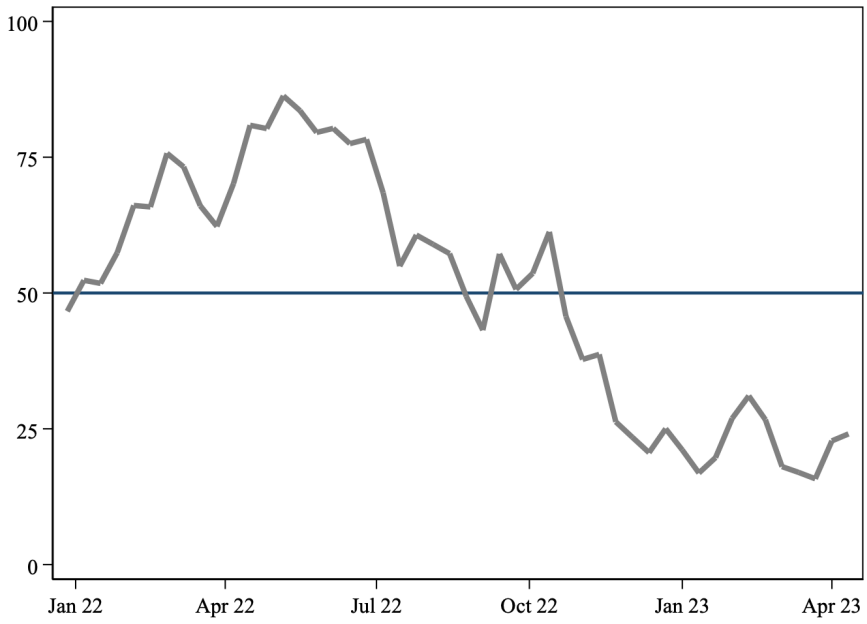


Figure 8: Break Diffusion Index, US Trends, 12-month Rolling Window

To build this diffusion index, we assign a value of 0 to all sectors with negative breaks, 50 to those with no breaks, and 100 to those with positive breaks in the previous 12 months. We then take a weighted mean using CPI weights. When this index is above 50, the trend breaks are mostly positive (more inflation), and when it is below 50, the trend breaks are mostly negative (less inflation). When the index crosses 50, there is an inflection point. Consistent with the previous results, the US appears to have experienced an inflection point in trends in January and September 2022.

4.2 Other Countries

This section extends the analysis to the 25 countries in our sample. Although many of these countries experienced similar inflation dynamics during the first two years of the COVID Pandemic, our data suggest their inflation trends started to diverge significantly in mid-2022. This can be seen for a set of selected countries in Figure 9.

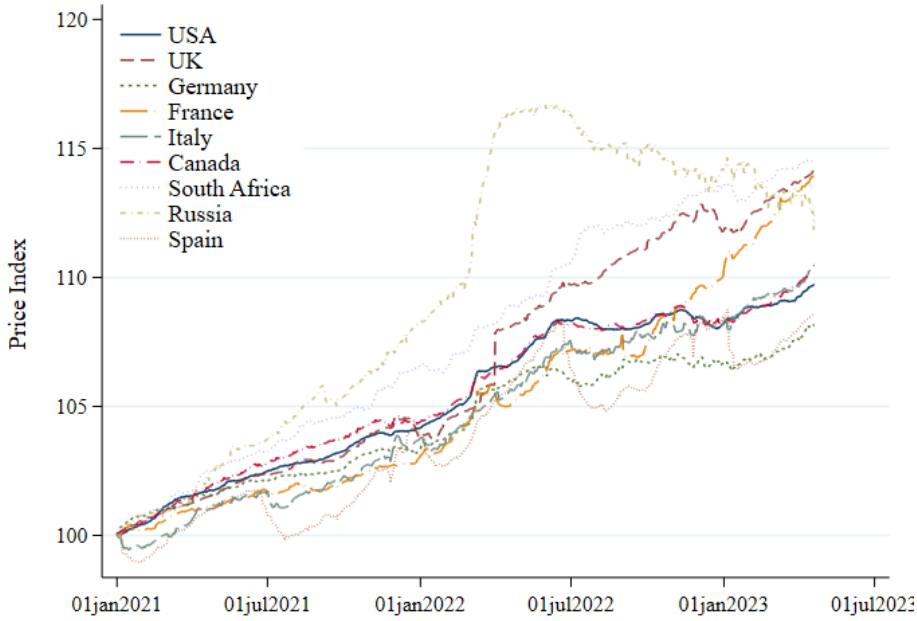


Figure 9: Aggregate Daily Price Indices - Selected Countries

In the graph, Russia emerges as an outlier, displaying a striking surge in prices immediately following the invasion of Ukraine, with a deceleration occurring a few months later. The majority of European countries exhibited common patterns until mid-2022, when they started to diverge. Some countries, such as Germany, underwent structural slowdowns around the same time as the US, while others, like France, appear to have accelerating inflation trends.

To understand how widespread the breaks are at the country level, we extend our analysis with disaggregated sectors in each country. We estimate the structural breaks in each of the 3-digit COICOP sectors and then compute the shares of weights that have breaks using the 12-month rolling windows.

In Table 1, we show the shares of CPI weights that have experienced negative, positive, or no trend breaks during the window that goes from April 2022 until April 2023. We rank countries by the difference between positive and negative breaks. In Figure A1 we show the diffusion index of each country for all the 12-month rolling windows between January 2022 and April 2023.

	Negative Break (Less inflation)	No break	Positive Break (More inflation)
Colombia	3	5	84
Argentina	9	0	88
South Africa	22	5	72
UK	20	16	60
China Fresh Food	23	0	48
France	29	14	50
Japan	17	33	38
Poland	31	17	50
Russia	43	0	57
Netherlands	39	8	52
Turkey	43	0	52
New Zealand	40	14	45
Spain	39	16	43
Korea	40	14	44
Italy	46	8	46
Greece	36	14	36
China Supermarket	36	0	36
Brazil	37	24	35
Australia	35	21	29
Uruguay	40	28	31
Ireland	50	5	37
Chile	44	23	27
Mexico	56	13	26
Germany	56	14	21
USA	61	26	11
Canada	65	15	13

Table 1: Share (%) of CPI Weights with Structural Breaks, April 2023

Notes: This table shows the percentage of 3-digit CPI weights that experienced a structural break between April 20th, 2022, and April 20th, 2023. The estimated break can be negative (less inflation) or positive (more inflation). If no break was detected, the weight from that sector is assigned to the "no break" column. Countries in the table are ranked by the difference between the share of negative and positive breaks.

About half of the countries have more CPI weights with positive breaks than negatives, meaning inflation was still accelerating. Argentina and Colombia are at the top, with more than 80% of sector weights experiencing positive structural breaks. On the other extreme are Canada and the US, where more than 60% of weights had negative breaks.

The most surprising results in this table are the differences within Europe. The UK is near the top with 60% of weights experiencing more inflation. France is nearby with 50 % of positive breaks. On the other end is Germany, with 56% of negative breaks and only 21% of positive ones. This suggests the factors driving inflation in Europe were becoming more country-specific at this stage of the inflation crisis. We later show that this divergence is still present when we exclude fuel and food from the analysis.

In Figure 10, we show the April 2023 values of the diffusion index for each country. As expected, the results are consistent with the ones in Table 1.

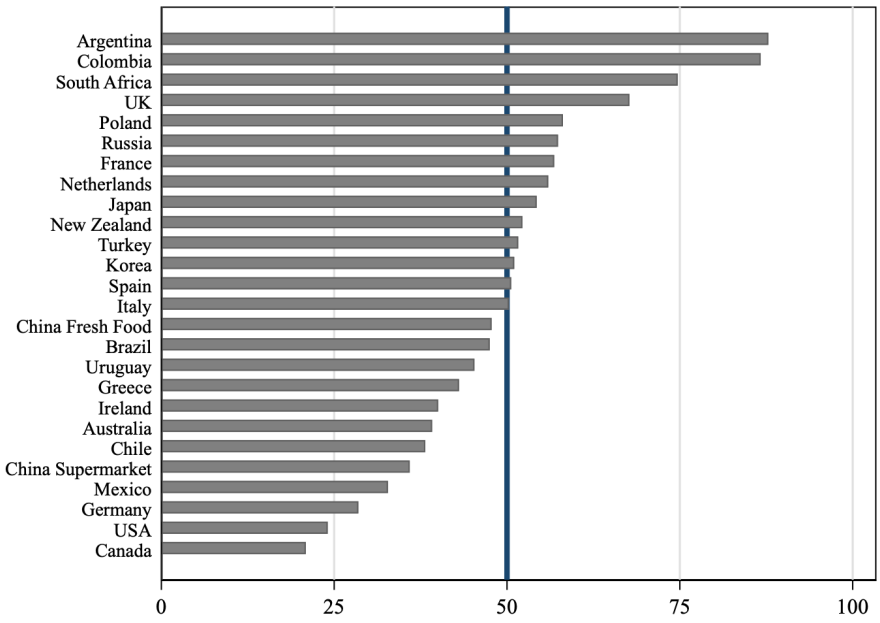


Figure 10: Break Diffusion Index, April 2023

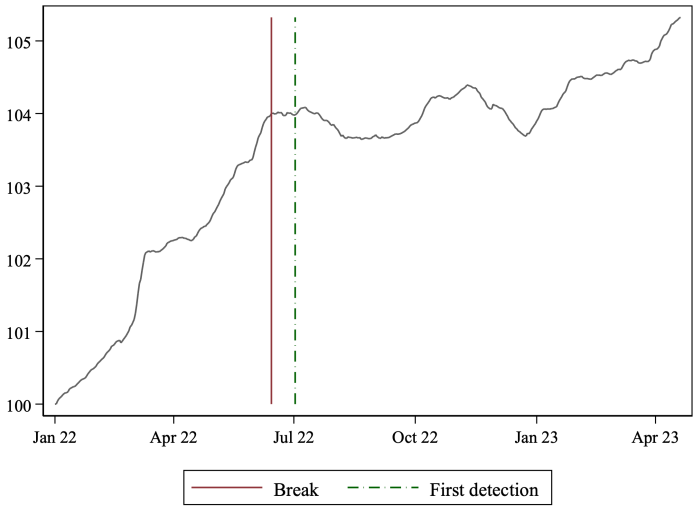
5 CPI data

In this section, we show the importance of high-frequency data by comparing some of our results with those obtained with monthly CPI indices. Our comparison is limited to the aggregate indices because we only have CPI data at the 1-digit COICOP level for every country. Nevertheless, we can show the advantage that daily data provides for the early detection of structural breaks.

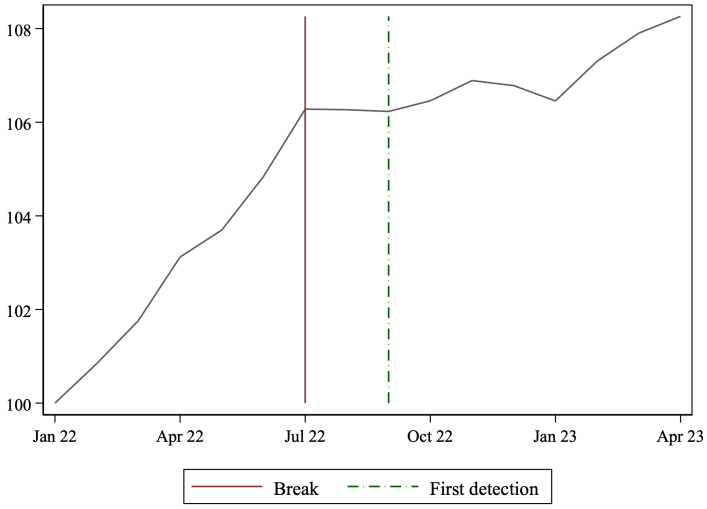
We conduct a structural breaks analysis on the aggregate price series of the US using both daily and monthly data. As Figure 2 suggests, this series experienced a trend break during June 2022. As noted in section 4.1, this break occurred on June 14th, 2022. Our goal is to compare the detection speed of both data, defined as the time it takes to detect the break. To do so, we need to calculate how many days are required to detect the break on June 14th, 2022 using the daily data and how many months are required to detect the break on June 2022, using the monthly data. We proceed as follows: 1) we keep the data until the first period after the break (i.e., we keep data until June 15th, 2022, for the daily index, and we keep data until July 2022 for the monthly index); 2) we run a structural break analysis; 3) if we are not able to detect the break, we add one more observation; 4) we repeat this process until each methodology detects the break.

The results are shown in Figure 11. With the daily index, the break can be first detected on July 2nd, about two and a half weeks after its occurrence. Instead, if we use the monthly CPI index,

we can not detect the break until September. This means it would have taken more than three *months* to detect the break with CPI data, while it would have taken about two weeks using the daily data. In addition, to detect the break with the CPI data, we needed an additional full year of historical data, with the sample starting on January 1st, 2021.



(a) Daily data - PS Index



(b) Monthly data - CPI

Figure 11: Detection speed - Daily Data vs CPI

Notes: This figure compares the speed of detecting breaks using daily and monthly data. We define speed as the distance between the break (red vertical line) and the first time that the data allows detecting that break (green vertical line). Panel (a) uses daily data from January 1st, 2022. Panel (b) uses daily data starting in July 2021. We consider a broader period of time in panel (b) because monthly frequency reduces the number of observations, and we can not apply the methodology described in Section 3 using only data from 2022. .

We emphasize that the main advantage here is the high frequency, not the real-time availability of the data. The reason is simply that the daily index can provide enough information to estimate trends and structural breaks within a few weeks. With monthly CPI data, it takes much longer to detect the same breaks in inflation trends, limiting the use of these techniques to make more timely policy decisions.

6 Additional Results

6.1 Core Sectors

We now show the results when excluding food and energy-related sectors. Overall, we find less strong evidence of a slowdown when focusing on core sectors, even though the share of weights experiencing negative breaks increases over time.

We start our analysis with the US. Figure 12 plots the share of Core weights that have experienced negative or positive breaks in the previous 12 months. This suggests two inflection points. One in January 2022, similar to headline. And another in November 2022, about two months after the one in the headline sectors.

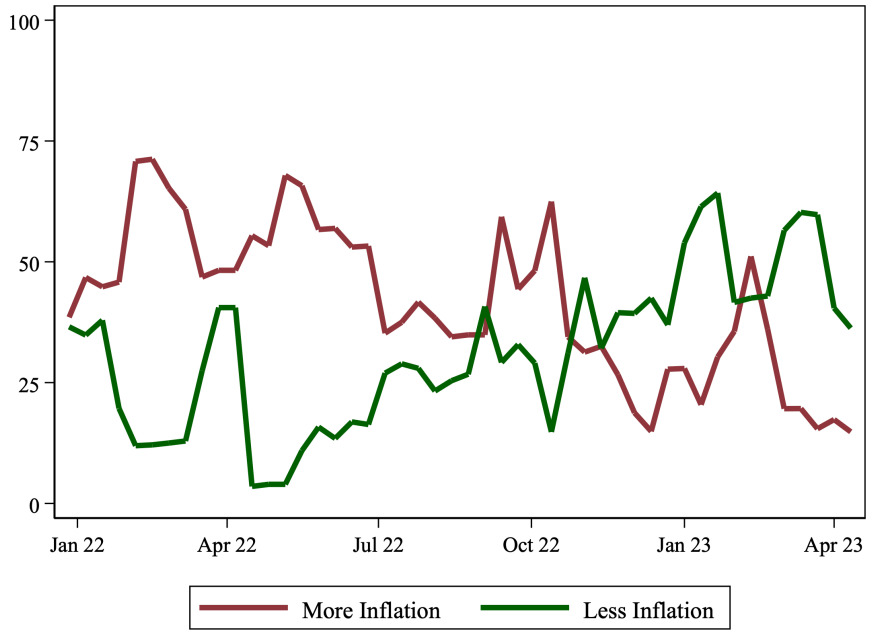


Figure 12: Share (%) of US CPI weights with structural breaks - 12-months Rolling Window

Table A3 summarizes April 2023 results for all countries. The ranking of countries is roughly the same as we had in the headline results, but this time only five countries have more negative breaks than positives: Uruguay, Japan, the US, Germany, and Canada.

	Negative Break (Less inflation)	No break	Positive Break (More inflation)
Argentina	0	0	100
Colombia	3	5	81
Russia	13	0	87
South Africa	10	5	82
Turkey	17	0	81
UK	9	19	70
Korea	17	12	68
Mexico	19	3	64
Poland	21	19	59
Netherlands	27	11	61
Greece	12	21	46
Italy	30	8	63
Brazil	19	38	41
Spain	29	20	50
Chile	23	31	41
Ireland	33	9	46
France	32	11	45
New Zealand	41	10	49
China Supermarket	13	0	18
Australia	26	22	31
Uruguay	50	1	48
Japan	28	26	23
USA	36	45	15
Germany	52	15	19
Canada	63	8	22

Table 2: Share (%) of CORE CPI Weights with Structural Breaks, April 2023

Notes: This table shows the percentage of 3-digit CORE CPI weights that experienced a structural break between April 2022 and April 2023. The estimated break can be negative (less inflation) or positive (more inflation). If no break was detected, the weight from that sector is assigned to the "no break" column. Countries in the table are ranked by the difference between the share of negative and positive breaks.

These results suggest that core inflation has not yet reached an inflection point in most countries. The same conclusion can be reached if we analyze the diffusion index, as shown in Figure 13.

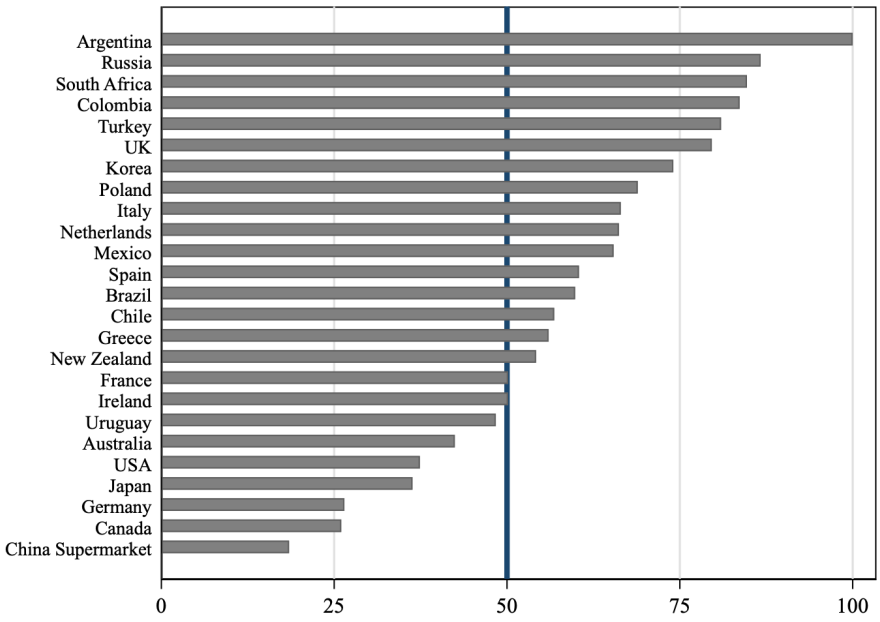
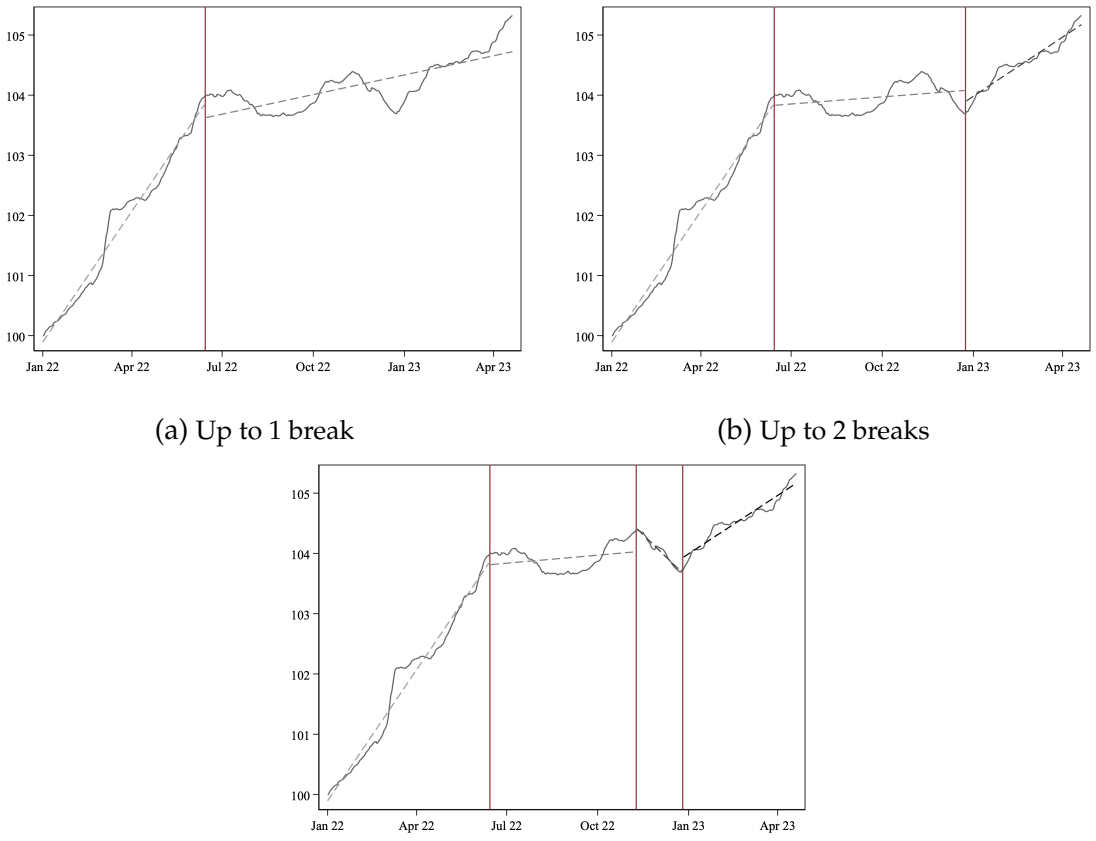


Figure 13: Break Diffusion Index, Core Sectors, April 2023

6.2 Multiple Breaks

This section shows the results of applying the multiple break procedure described in Section 3. We first consider the impact on the US aggregate series and then apply the method to the disaggregated data in all countries.

In the aggregate series, allowing for multiple breaks can help us detect more nuanced changes. As Panel (a) in Figure 14 shows, when allowing for a single break, we can only detect the largest break. However, there might be other relevant breaks. In panels (b) and (c), we allow for two and three breaks, respectively.



(a) Up to 1 break

(b) Up to 2 breaks

(c) Up to 3 breaks

Figure 14: Multiple Break Tests - US Aggregate Index

While this approach can identify multiple breaks, it can also detect trend shifts that are irrelevant for some analyses. For instance, although the three breaks detected in Panel (c) lead to significant reductions in the sum of squared residuals, the second breakpoint does not appear so meaningful for understanding inflation dynamics. In cases like this, considering a broader period may suffice to eliminate non-meaningful breakpoints, as demonstrated in Figure A5.

In addition, allowing for multiple breaks does not significantly change our main results when using disaggregated 3-digit series. The reason can be seen in Table 3. Even though we allow multiple breaks, only 11.9% of all subsectors have more than one break. Only the most volatile categories, such as Food, Transportation (fuel), and Recreation, have a more significant percentage of subsectors with multiple breaks.[2]

[2]See Figure A4 in the Appendix for an example with US Fuel.

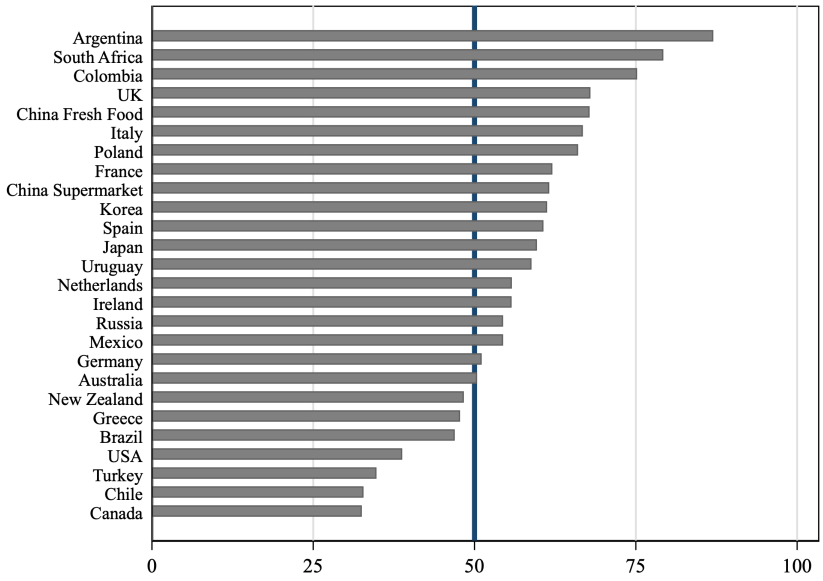
	No breaks	One break	Two breaks	Three breaks
Food and beverages	40 (14%)	207 (72.4%)	24 (8.4%)	15 (5.2%)
Alcoholic beverages	27 (30.7%)	52 (59.1%)	4 (4.5%)	5 (5.7%)
Clothing and footwear	11 (14.3%)	52 (67.5%)	5 (6.5%)	9 (11.7%)
Water, electricity, other fuels	19 (21.6%)	60 (68.2%)	4 (4.5%)	5 (5.7%)
Household and Furnishings	60 (27.4%)	146 (66.7%)	12 (5.5%)	1 (.5%)
Health	15 (27.3%)	35 (63.6%)	4 (7.3%)	1 (1.8%)
Transport	16 (19.3%)	49 (59%)	7 (8.4%)	11 (13.3%)
Communication	9 (27.3%)	21 (63.6%)	1 (3%)	2 (6.1%)
Recreation and culture	81 (27.5%)	192 (65.1%)	14 (4.7%)	8 (2.7%)
Restaurants and hotels	4 (33.3%)	3 (25%)	1 (8.3%)	4 (33.3%)
Miscellaneous	20 (25.6%)	52 (66.7%)	3 (3.8%)	3 (3.8%)
All sectors	302 (23%)	869 (66.1%)	79 (6%)	64 (4.9%)

Table 3: Number of 3-Digit Sectors with Multiple-Breaks

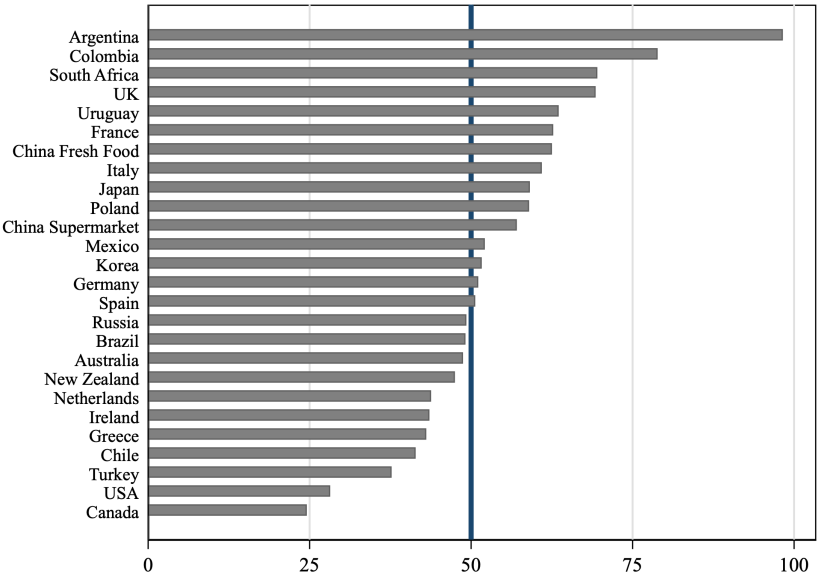
Notes: This table shows the number and percentage of 3-digit subsectors that experienced zero, one, two, or three breaks between April 2022 and April 2023. We make no distinction here if the break is negative or positive. The rows provide statistics grouped at the 1-digit sector level. All countries are included.

Figure 15 shows the April 2023 values for a break diffusion index in each country obtained using the multiple-break strategy. When identifying a single break, we define the direction of the break by comparing the pre-break and post-break trends. However, deciding what trends to compare is not trivial when identifying multiple breaks. For instance, if a sector had an index that looked like Figure 14, the results would differ according to the trends we compare. If we focus on the difference between the last two trends, we classify the break as positive (more inflation). Instead, if we focus on the difference between the last and first trends, we classify the break as negative (less inflation). To avoid this concern, we report the results for both approaches.

Despite minor differences, the results in panels (a) and (b) are similar. Regardless of what trends we compare in the multiple breaks case, the ranking of countries in these charts remains mostly the same. Importantly, the results in both panels are similar to the ones in Figure 10, indicating that although helping us identify relevant breaks in some sectors, the multiple-break approach does not significantly change our main results.



(a) Trend change within last two regimes



(b) Last regime vs. first regime

Figure 15: Break Diffusion Index with Multiple Breaks, April 2023

6.3 Conclusions

The results in this paper prove that simple structural break tests can be effectively combined with high-frequency price indices to detect changes in inflation trends in a matter of weeks, compared with the several months required with traditional CPI data. We illustrated the usefulness of this approach for real-time analysis and policy-making by studying the recent period of high inflation,

from January 2022 to April 2023, in 25 countries.

We found evidence of broad-based negative structural breaks in headline inflation trends for about half of the countries in our sample, including Spain, China, Russia, Canada, and the US. There is, however, significant heterogeneity in recent inflation dynamics. Some countries, such as Argentina, Poland, and France, are still experiencing more positive than negative breaks. For core sectors, only a handful of countries appear to have reached an inflection point, even though the number of negative breaks is rising.

Finally, we expect the availability of high-frequency inflation data to increase in the following years as more national statistical agencies improve their data collection with online prices and similar methods.[3] As this happens, more research will be needed to develop summary statistics and other measures that help economists and central bankers understand when and how structural breaks affect inflation dynamics.

[3]Some early research examples include work by the US Bureau of Labor Statistics (See Horrigan 2013a), the UK Office of National Statistics (Breton et al. 2015), Statistics Netherlands (Griffioen, de Haan, Willenborg 2014), Statistics New Zealand (Krsinich 2015), and Statistics Norway (Nygaard 2015). These efforts increased after the Covid lockdowns disrupted traditional data collection methods. See of Sciences and Medicine (2022).

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A Additional Tables and Figures

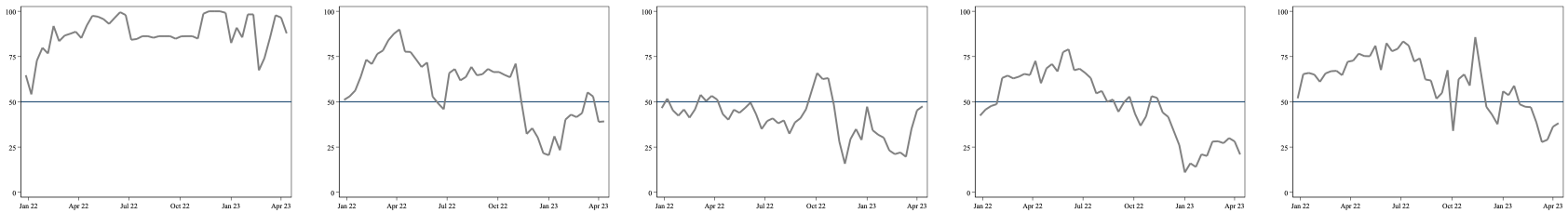
	No breaks	One break	Two breaks	Three breaks
Argentina	1 (2.3%)	38 (88.4%)	2 (4.7%)	2 (4.7%)
Australia	9 (17.3%)	38 (73.1%)	3 (5.8%)	2 (3.8%)
Brazil	15 (29.4%)	34 (66.7%)	2 (3.9%)	0 (0%)
Canada	13 (23.6%)	36 (65.5%)	4 (7.3%)	2 (3.6%)
Chile	19 (37.3%)	32 (62.7%)	0 (0%)	0 (0%)
China Fresh Food	32 (84.2%)	6 (15.8%)	0 (0%)	0 (0%)
China Supermarket	29 (65.9%)	15 (34.1%)	0 (0%)	0 (0%)
Colombia	13 (24.5%)	35 (66%)	3 (5.7%)	2 (3.8%)
France	9 (17%)	40 (75.5%)	2 (3.8%)	2 (3.8%)
Germany	13 (25.5%)	32 (62.7%)	2 (3.9%)	4 (7.8%)
Greece	14 (26.4%)	33 (62.3%)	2 (3.8%)	4 (7.5%)
Ireland	13 (25.5%)	30 (58.8%)	2 (3.9%)	6 (11.8%)
Italy	6 (12%)	35 (70%)	6 (12%)	3 (6%)
Japan	18 (31.6%)	34 (59.6%)	3 (5.3%)	2 (3.5%)
Korea	15 (28.3%)	29 (54.7%)	5 (9.4%)	4 (7.5%)
Mexico	14 (27.5%)	33 (64.7%)	2 (3.9%)	2 (3.9%)
Netherlands	8 (15.4%)	33 (63.5%)	4 (7.7%)	7 (13.5%)
New Zealand	11 (22.4%)	28 (57.1%)	4 (8.2%)	6 (12.2%)
Poland	9 (18%)	37 (74%)	3 (6%)	1 (2%)
Russia	2 (4.1%)	20 (40.8%)	11 (22.4%)	16 (32.7%)
South Africa	6 (11.5%)	39 (75%)	3 (5.8%)	4 (7.7%)
Spain	5 (10%)	30 (60%)	8 (16%)	7 (14%)
Turkey	4 (8.3%)	37 (77.1%)	3 (6.3%)	4 (8.3%)
UK	9 (17%)	38 (71.7%)	3 (5.7%)	3 (5.7%)
Uruguay	9 (18.8%)	38 (79.2%)	1 (2.1%)	0 (0%)
USA	13 (23.2%)	35 (62.5%)	5 (8.9%)	3 (5.4%)
All Countries	309 (23.4%)	837 (63.4%)	84 (6.4%)	90 (6.8%)

Table A1: Multiple-Break Test Results by Country and Number of Breaks Detected

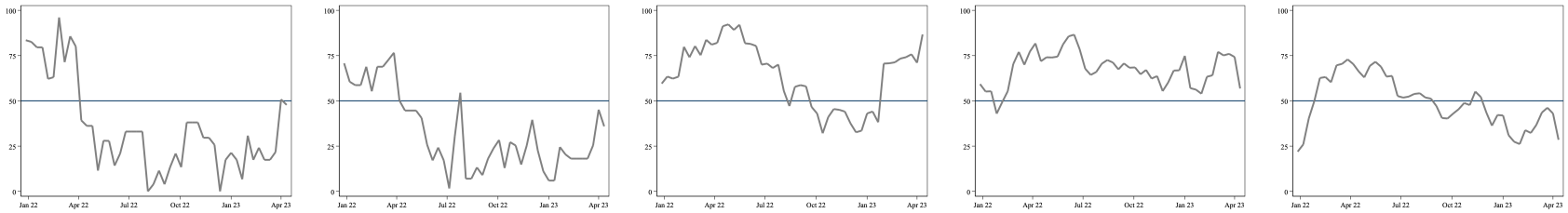
	Less inflation	No break	More inflation
Spain	79	3	18
China Supermarket	66	28	6
Russia	78	2	20
Canada	69	14	16
USA	67	19	14
China Fresh Food	58	29	12
Brazil	60	24	16
Uruguay	59	21	21
Australia	53	21	25
Germany	47	24	29
Greece	44	30	27
Mexico	44	28	28
Chile	39	37	25
Ireland	44	24	32
New Zealand	35	21	44
Netherlands	40	10	50
Turkey	43	5	53
UK	32	19	49
Japan	21	38	40
Korea	29	20	51
Italy	36	6	58
Colombia	25	20	56
South Africa	24	8	68
France	19	17	64
Poland	23	8	69
Argentina	0	3	97

Table A2: Share (%) of CPI Weights with Structural Breaks, Jan2022-April 2023

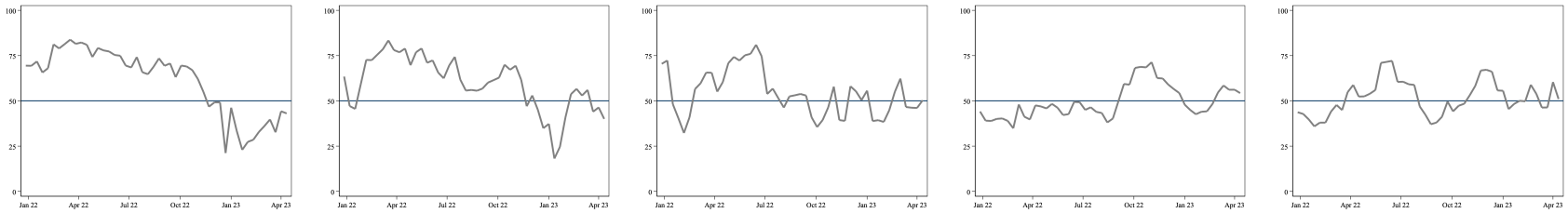
Notes: This table shows the percentage of 3-digit CPI weights that experienced a structural break between January 12th, 2022, and April 2023. The estimated break can be negative (less inflation) or positive (more inflation). If no break was detected, the weight from that sector is assigned to the "no break" column. Countries in the table are ranked by the difference between the share of negative and positive breaks.



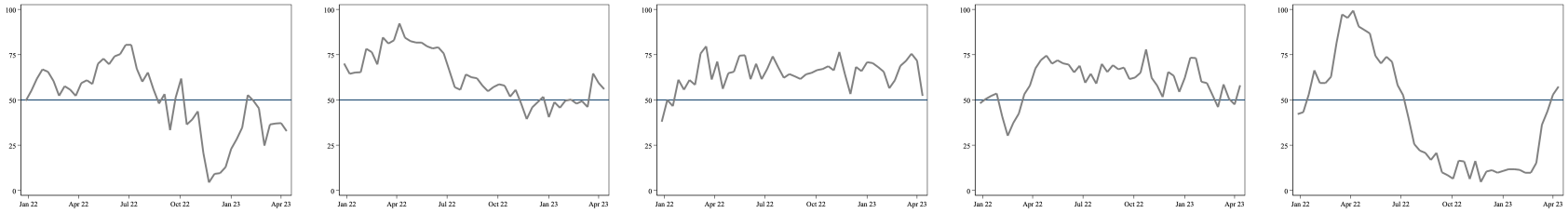
(a) Argentina (b) Australia (c) Brazil (d) Canada (e) Chile



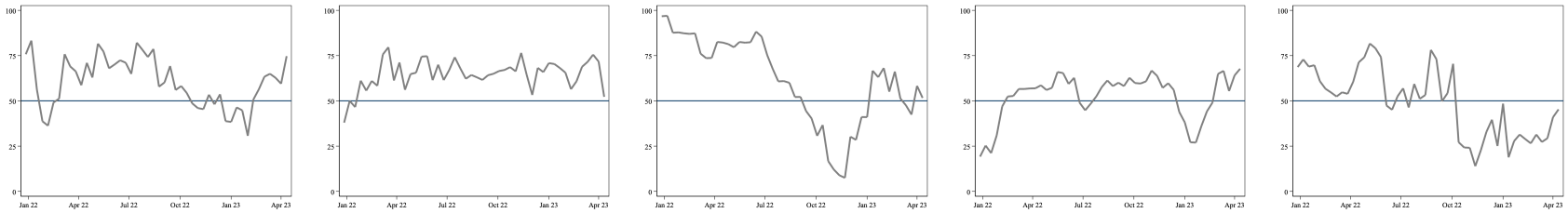
(f) China FF (g) China S (h) Colombia (i) France (j) Germany



(k) Greece (l) Ireland (m) Italy (n) Japan (o) Korea



(p) Mexico (q) Netherlands (r) New Zealand (s) Poland (t) Russia



(u) South Africa (v) New Zealand (w) Turkey (x) UK (y) Uruguay

Figure A1: Diffusion Index - All Countries

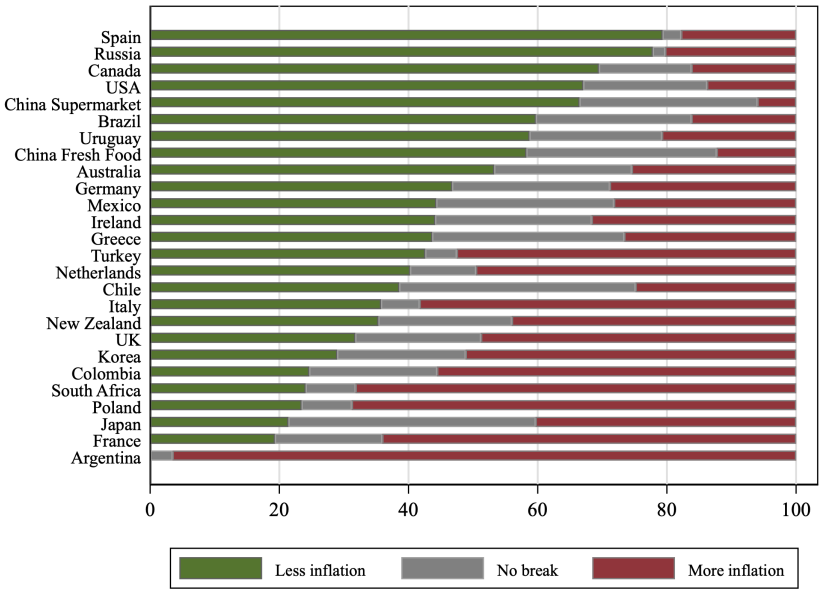


Figure A2: Share (%) of CPI weights by type of break, April 2023

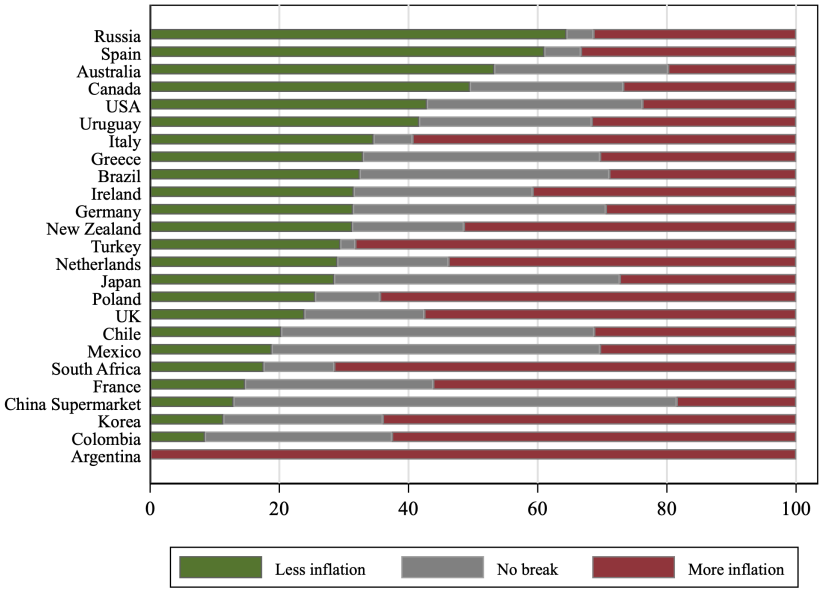
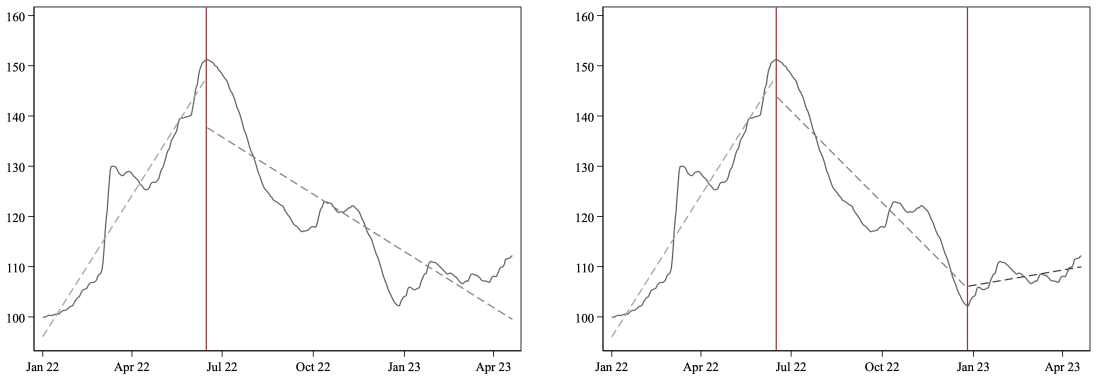
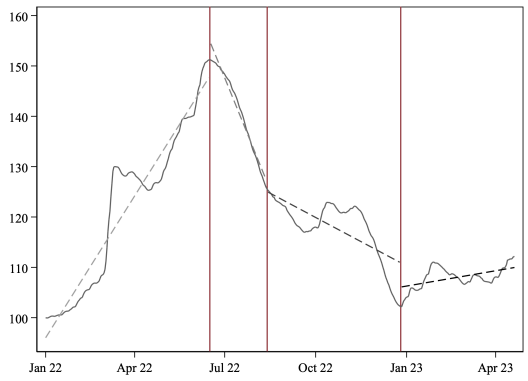


Figure A3: Share (%) of CPI weights by type of break - Core Sectors



(a) Up to 1 break

(b) Up to 2 breaks



(c) Up to 3 breaks

Figure A4: Multiple Break Tests - US Fuel Index

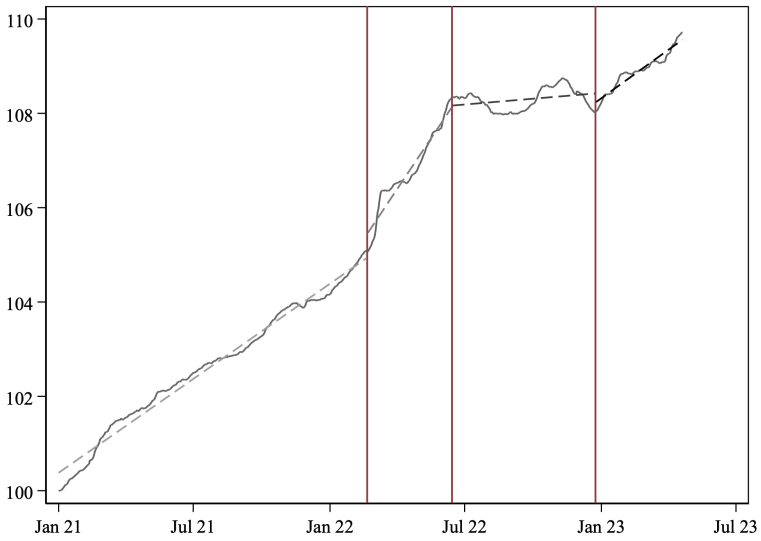


Figure A5: Multiple Break Tests - US Aggregate Index from January 2021