Price Setting Before and During the Pandemic: Evidence from Swiss Consumer Prices

Barbara Rudolf[†]
Swiss National Bank

Pascal Seiler[‡]
ETH Zurich

May 2025

Abstract

Using microdata underlying the Swiss consumer price index from 2008 to 2022, we provide new evidence on price rigidity at the product level. The frequency of price changes increased in the decade before the pandemic and accelerated thereafter. While much of the increase before the pandemic occurred in products where collection switched to online prices, the increase during the post-pandemic inflation surge was broad-based. Assessing the contributions of the extensive and intensive margins of price adjustment to variations in inflation shows that firms adjust mainly the overall size of price changes rather than their frequency in response to aggregate shocks, which is consistent with predictions from time-dependent pricing models. However, nonlinear local projections suggest that the responsiveness of prices to aggregate shocks varies over time.

JEL Classification: E31, E5, L11
Keywords: Price rigidity, price-setting behavior, consumer prices, inflation, state dependence, COVID-19 pandemic

---

For helpful comments and suggestions, we thank two anonymous referees of the ECB Working Paper Series, Rachel Arulraj-Cordonier, Luca Dedola, Erwan Gautier, Petra Gerlach, Hans Gersbach, Peter Karadi, Sarah Lein, Carlos Lenz, Jan-Egbert Sturm, Peter Zorn, and Mathias Zurlinden, as well as the seminar participants at the EEA-ESEM 2022, ETH Zurich, the European Central Bank, the SEA conference 2021, the Spring Meeting of Young Economists 2022, the Annual Congress 2022 of the SSES, the Swiss National Bank, and the University of Basel. We would also like to thank Corinne Becker and Hans-Markus Herren of the Swiss Federal Statistical Office for their valuable help with the data. The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the authors. They do not necessarily reflect the views of the Swiss National Bank (SNB). The SNB takes no responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper.
[†]Swiss National Bank, Monetary Policy Analysis, P.O. Box, CH–8022 Zurich, Switzerland. E-mail: barbara.rudolf@snb.ch. [‡]ETH Zurich, KOF Swiss Economic Institute, Leonhardstrasse 21, CH–8092 Zurich, Switzerland. E-mail: seiler@kof.ethz.ch. Web: https://www.pascalseiler.ch.

1 Introduction

Price rigidity is a cornerstone of many macroeconomic models. The assumption that prices do not respond immediately to changes in supply and demand gives rise to monetary non-neutrality. A monetary stimulus affects real activity and transmits slowly into inflation. Therefore, understanding the extent of price rigidity and the factors influencing price adjustments is vital for policymakers committed to price stability.

This paper analyzes firms' price-setting behavior using microdata underlying the Swiss consumer price index (CPI). These data are monthly price quotes collected by the Swiss Federal Statistical Office (FSO) to construct the Swiss CPI. Our sample covers the period from January 2008 to December 2022. We identify 177,000 individual price series at the outlet level for 1,300 different goods and services for which prices were collected in more than 3,000 stores across Switzerland. After excluding prices such as administered prices or those based on unit value indices, the sample consists of 8.6 million price quotes, covering 60 percent of CPI expenditures.

In line with earlier studies, we find evidence of considerable price rigidity. The frequency of price changes is 26.2 percent, meaning that more than one in four prices changes each month. Price increases (14.0 percent) are slightly more frequent than price decreases (12.2 percent). Temporary sales and product substitutions are common in Swiss consumer prices and account for approximately two percentage points each of the frequency of price changes. Cross-sectoral heterogeneity is another prominent feature of price adjustment frequencies. Prices of energy and unprocessed food change most frequently, while prices of services are adjusted relatively infrequently. Overall, consumer prices in Switzerland are more flexible than the euro area average (Gautier et al., 2024) but about as flexible as those in the United States (Nakamura and Steinsson, 2008) if we disregard price changes related to temporary sales in comparison with the United States.

We observe significant changes in price rigidity before and during the coronavirus (COVID-19) pandemic. Before the pandemic, from January 2008 to January 2020, price rigidity weakened as the frequency of price changes increased continuously from 21.9 percent in 2008 to 30.0 percent in 2019. At the same time, the interquartile range of price adjustment frequencies widened over time. In particular, the 75th percentile increased more than the 25th percentile. Hence, this development is not the result of a broad-based tendency toward more frequent price adjustments but rather reflects a significant increase in the frequency of price changes in a subset of the CPI. We show that products for which the FSO has moved to collect prices online are among the items with the largest increase in the price adjustment frequency. The greater price transparency and competition in online markets may explain why firms change online prices more often.

The period during the pandemic, from February 2020 to the end of our sample in December 2022, initially showed a decline in the frequency of price changes. At the aggregate level, prices were adjusted less frequently in 2020 than in the preceding years, and price changes were smaller on average. There are two explanations for this trend reversal. First, responses varied widely across sectors, muting the aggregate response. Second, the high uncertainty associated with the pandemic may have impeded price adjustments. Furthermore, we find that the pandemic increased the frequency of temporary sales in the non-energy industrial goods (NEIG) sector and decreased the corresponding frequency in the food sector. Hence, temporary sales responded countercyclically to the respective demand conditions across sectors. After its initial decline, the frequency of price adjustments showed a renewed increase in 2021 and 2022. Unlike the pre-pandemic period, however, this increase was broad-based: We observe not only an increase in the upper percentiles but an upward shift in the entire distribution of price adjustment frequencies.

We then analyze the implications for aggregate price dynamics. We find that variations in the size of price changes provide a larger contribution to variations in inflation than variations in the frequency of price changes. However, the weak contribution of variations in the price adjustment frequency largely reflects offsetting shifts in the frequency of price increases and the frequency of price decreases. Considered separately, variations in the frequency of price increases and decreases contribute significantly to variations in inflation.

Finally, we examine how the frequency and size of price changes affect the response of prices to different aggregate shocks in a panel local projections framework. Our results show that firms, on average, adjust the size rather than the frequency of price adjustments. This behavior is consistent with the predictions of a time-dependent pricing model, where idiosyncratic shocks are more important in motivating price changes than aggregate shocks. However, when we use item-level empirical measures of the "sufficient statistic" proposed by Alvarez et al. (2016) to account for time variation in firms' price-setting behavior, we find that the responsiveness of prices to aggregate shocks varies over time. In periods when the sufficient statistic is low—characterized by either high price flexibility, strong price selection, or both—firms respond to aggregate shocks not only through the size of price changes but also by increasing their price adjustment frequency. This behavior aligns with predictions from state-dependent pricing models.

There is a vast empirical literature on price-setting behavior, some of which is based on CPI microdata.[1] Bils and Klenow (2004), Klenow and Kryvtsov (2008), and Nakamura and Steinsson (2008) use CPI micro prices to characterize price rigidity in the United States. Similarly, Dhyne et al. (2006) summarize price adjustment features of 50 narrowly defined products for ten euro area countries. Gautier et al. (2024) expand and update that study as part of the Price-Setting Microdata Analysis Network (PRISMA) established by the European System of Central Banks (ESCB). For Switzerland, Kaufmann (2009) examines price rigidity in Swiss consumer prices using quarterly data from 1993 to 2005. On a smaller scale, Föllmi et al. (2016) analyze price setting in a range of non-tradable services representing 4 percent of the Swiss CPI, such as hairdressing, cinemas, or food & drinks in restaurants.

Our contribution to this literature is threefold. First, we update and extend earlier results on price rigidity in Switzerland. Furthermore, our data allow us to explore new aspects of price rigidity, including the effect of the rise of e-commerce. In our data, the share of price quotes collected online has increased sharply in recent years to over 20 percent in 2022. Several recent studies focused on the effect of online retailing on price setting in specialized datasets. Using web-scraped

[1] Klenow and Malin (2010), Nakamura and Steinsson (2013) and Dedola et al. (forthcoming) provide comprehensive reviews of micro price studies and summarize the available microeconomic evidence on price-setting behavior.

prices from multi-channel retailers in the US, Cavallo (2018a) documents that online competition has increased the frequency of price changes from 2008 to 2017. Gorodnichenko and Talavera (2017) and Gorodnichenko et al. (2018) show that prices in online marketplaces are more flexible than the micro prices collected in a store. By uncovering similar trends in the Swiss CPI microdata, we document the role of online retailing as a source of greater price flexibility in the data underlying a national CPI.

Second, we analyze the effect of the COVID-19 pandemic on price setting at the CPI micro level. The pandemic and the measures to contain it greatly restricted business operations and consumer expenditures. A burgeoning literature explores the effects on firms' price-setting behavior using various sources of price data, including CPI microdata (Montag and Villar, 2022), survey data (Balleer et al., 2024), supermarket scanner data (Karadi et al., 2023), and online data (Alvarez and Lein, 2020; Cavallo and Kryvtsov, 2023; Henkel et al., 2023). We contribute to the literature by focusing on firms' sales policies in addition to the conventional price-setting moments emphasized in most studies. Our finding that temporary sales responded countercyclically to sectoral demand conditions during the pandemic supports the view that firms use their sales policy to adjust to aggregate shocks (e.g., Klenow and Willis, 2007; Kryvtsov and Vincent, 2021).

Third, we contribute to the literature that studies the role of firms' individual price adjustment margins in shaping aggregate price dynamics (Gagnon, 2009; Wulfsberg, 2016; Nakamura et al., 2018; Alvarez et al., 2019) and their importance in the transmission of aggregate shocks to inflation (Balleer and Zorn, 2019; Dedola et al., 2021; Gautier et al., 2024). Most of these studies use data from periods when inflation was low, or they study firms' average responses. We add to this literature by accounting for time variation in firms' price-setting behavior using empirical moments of the "sufficient statistic" proposed by Alvarez et al. (2016) at the item level. Our results are consistent with empirical findings that the frequency of price changes increases in response to large shocks (Cavallo et al., 2024). This is also consistent with predictions from state-dependent models of price rigidity (e.g., Golosov and Lucas, 2007; Woodford, 2009).

The remainder of this paper is organized as follows. Section 2 describes the microdata underlying the Swiss CPI. Section 3 presents evidence on the frequency and size of price changes over the period from 2008 to 2022 from an aggregate, a cross-sectional, and a time-series perspective. Section 4 and Section 5 cover the analysis of price rigidity in Switzerland for the periods before and during the pandemic, respectively. Section 6 analyzes the implications of the firms' price adjustment margins for aggregate price dynamics. Section 7 concludes.

2 Data

This paper is based on monthly price quotes collected by the Swiss Federal Statistical Office (FSO) from January 2008 to December 2022 to construct the CPI for Switzerland.[2]

[2]The data have been provided to the Swiss National Bank and the KOF Swiss Economic Institute at ETH Zurich by the Swiss Federal Statistical Office based on a confidentiality agreement and cannot be shared.

2.1 Price quotes

A price quote $P_{p,s,t}$ is the transaction price of an individual product p sold in a particular store s in a given month t. For each price quote, the FSO records attributes such as product category, store, collection date, packaging size[3], and other characteristics. These data allow us to track individual prices over time.

Prices are collected for narrowly defined product categories ("varieties") that form the lowest level of the basket of goods and services, which is based on the Classification of Individual Consumption by Purpose (COICOP). "Expenditure items" correspond to the five-digit COICOP level and represent the level at which the FSO publishes price indices and expenditure weights. These weights reflect the relative importance of the basket components and are derived from the Household Budget Survey, updated annually.[4] To compute aggregate statistics, we distribute the expenditure-item weight equally across all price quotes within the item.

2.2 Price collection

Traditionally, the FSO collected the vast majority of prices directly in stores. However, the share of in-store observations has declined over time, with less than half of the price quotes recorded in this way in 2022 (see Figure A.1 in the appendix). Much of the decline in the share of in-store observations can be attributed to the increasing use of scanner data and web-scraped data. Since 2008, the FSO has incorporated scanner data from major retailers, which has improved data quality and administrative efficiency. As shown in Figure A.2 in the appendix, most of these prices are prices for food and near-food products (including personal care, washing and cleaning products, and animal food). Additionally, the FSO expanded the use of online price collection in response to the rise of e-commerce. From January 2016, prices for consumer electronics, package holidays, and air transport have been exclusively collected online. By 2022, over 20 percent of all price quotes came from internet sources.

2.3 Temporary sales

Prices fluctuate frequently due to temporary sales, i.e., short-term price discounts typically driven by seasonal patterns rather than broader macroeconomic conditions. Since these high-frequency movements can obscure underlying price-setting behavior, we distinguish between "posted prices" (including sales) and "regular prices" (excluding sales). When constructing regular prices, we replace each sales price—as flagged by FSO price collectors—with the most recent non-sales price. The FSO flags sales prices when discounts are temporary and available to all consumers without restriction.

However, these flags may be subject to measurement error—for instance, if a discount is not visibly marked as a special offer. To address this concern, we apply two alternative sales-filtering techniques

[3] Because the packaging size may change within a price series, we adjust prices to a consistent unit price to ensure that packaging variations do not introduce spurious price changes.

[4] In this study, similarly to Klenow and Kryvtsov (2008), we use time-varying (i.e., yearly) CPI weights. An alternative approach consists of using time-invariant CPI weights similar to Nakamura and Steinsson (2008).

as robustness checks: the symmetric V-shaped filter by Nakamura and Steinsson (2008) and the running mode filter by Kehoe and Midrigan (2015). The V-shaped filter classifies a price change as temporary if the price reverts to its prior level within a defined window. The running mode filter removes temporary price changes by creating regular prices based on the modal price in a running window.

2.4 Product substitutions

An important principle of price collection is to collect prices of the same items over time to capture the evolution of prices only. However, consumer markets evolve rapidly—products frequently change, enter, or disappear—requiring rules for product replacements and quality adjustments (see FSO, 2016). The FSO applies three main substitution methods: (i) direct substitution for nearly identical products (e.g., a vintage of a wine replacing another vintage of the same wine), (ii) the chain method for functional equivalents (e.g., a brand on the rise replacing another), and (iii) non-replacement when no suitable substitute exists. On average, direct substitution accounts for 1.8 percent of price observations per month, non-replacement for 1.5 percent, and the chain method for 0.3 percent. We also observe that substitutions of all types have become more frequent over time (see Figure A.4 in the appendix).

Our analysis considers price changes with and without product substitutions. Our baseline approach follows Klenow and Kryvtsov (2008), treating a price series as continuous despite substitution, thus taking potential quality adjustment into account. Alternatively, we examine price changes under the assumption that a new price series begins with every product substitution, effectively excluding all price changes linked to replacements.

2.5 Price imputations

Whenever a price is missing or cannot be observed, the FSO makes use of price imputations to maintain the calculation of the CPI. To ensure that imputations do not affect our analysis, we exclude them whenever possible. Some imputed prices, however, cannot be identified in our data. This primarily concerns prices for temporarily unavailable products. In these cases, the FSO carries forward the last observed price, typically for up to two months before requiring a substitution. Since the FSO does not flag imputations at the level of individual price quotes, these imputed prices cannot be removed from our sample.

However, two types of imputations can be identified and excluded. First, the prices of seasonal products are only recorded during the months in which the products are offered. The prices of these products carried forward in the off-seasons account for 15.4 percent of price observations (14.8 percent of CPI expenditures). Second, during the COVID-19 pandemic (March 2020 to May 2021), limited field data collection led to price imputations in the form of carry-overs of the last price observation or the insertion of trend information.[5] The FSO listed the affected expenditure items in the monthly CPI press releases (see Table A.1 in the appendix). While some prices within these items may have been observed as usual, we adopt a conservative approach and classify all price quotes for flagged items as "COVID imputations" during the affected months. Figure A.4 in the appendix illustrates the extent of price imputations during the pandemic.

2.6 Data treatment and sampling decisions

Our sample covers the period from January 2008 to December 2022, spanning 180 months. The beginning of this period is determined by the significant change in the price collection frequency (see Figure A.3 in the appendix). The prices of most goods and services were collected quarterly until December 2007 and monthly from January 2008 onward. This allows us to analyze monthly price changes over the period under consideration consistently.

We exclude three types of observations a priori. First, we exclude imputed prices (including prices of seasonal products recorded during the off-season and price imputations during the COVID-19 pandemic from March 2020 to May 2021, see Section 2.5). Second, we exclude items for which the FSO constructs auxiliary indices to track price movements rather than actual price quotes. Examples include rental prices or books.[6] In total, there are 19 index-based items, which account for 35.8 percent of the CPI in 2022. Third, we exclude items of administered and semi-administered prices because they are set by government authorities and centrally collected. Examples are electricity, public transport services, and medicines.[7] In total, there are 39 items of administered and semi-administered prices, which account for 26.0 percent of the CPI in 2022.

By excluding price observations reflecting indices and (semi-)administered prices, we exclude items for which measurement errors are frequent. However, measurement errors raise concerns beyond these two restrictions.[8] Therefore, we treat our data further as follows. First, we correct quantities for measurement errors when quantity changes exceed a factor of 10 (or fall below 1/10) and apply a carry-forward procedure to adjust unit prices affected by shifts in measurement units—affecting only 204 observations. Second, we trim extreme price changes beyond the 1st and 99th percentiles

[5] Specifically, when the number of missing prices was large or the price changes within the same product category were large and relatively homogeneous, the imputed prices were set to reflect the movement in the observed prices of products belonging to the same product category. When the number of missing prices was low or the price changes within the same category were small, the last recorded price was carried forward, implying no price adjustment.

[6] Items of index-based price observations are: housing rentals; rental of garages, parking spaces; imputed rent for owner-occupied dwellings; medicines; medical services at local surgery; in-patient hospital services; hire of private means of transport; second-hand cars; public transport: direct service; public transport: combined services; postal services; personal computers; recorded media; recreational boats; games of change; fiction books; school and educational books; other books; and private health insurance.

[7] Items of administered and semi-administered prices are: charges for household waste elimination; charges for water provision; charges for sewerage; maintenance and care-taking; gas; electricity; district heating; medicines; medical services at local surgery; dental services; physiotherapy, home care spitex; laboratory analyses; in-patient hospital services; out-patient medical services in hospitals; parking fees; taxes for private vehicles and driving school; public transport: direct service; public transport: combined services; taxi; postal services; admission to sport facilities; fees for radio and TV reception; compulsory education; post-compulsory education; higher vocational education and universities; social protection services; household insurance; private health insurance; and car insurance.

[8] See Eichenbaum et al. (2014) and Appendix B.2 for a discussion of measurement errors in small price changes.

of absolute log price changes for each variety, removing fewer than 2 percent of all price changes.[9]

Table 1 summarizes the effects of our sampling decisions on our data sample. The baseline data sample contains 8.6 million price quotes that form more than 177,000 price series. They spread over 266 expenditure items and nearly 1,300 varieties. The sample covers 54.1 percent of the CPI basket on average from 2008 to 2022. The largest expenditure items excluded are rents and homeowners' imputed rents, health services, and transportation services, whose average weights in the CPI are 23 percent, 14 percent, and 3 percent, respectively. The share of sales amounts to 5.0 percent of all observations, which is higher than the 3.8 percent in the euro area (Gautier et al., 2024) but lower than the 11 percent in the US (Klenow and Kryvtsov, 2008). The share of product substitutions amounts to 3.4 percent of all observations, which is similar to the share of 3.0 percent (Klenow and Kryvtsov, 2008) and 3.4 percent (Bils and Klenow, 2004) in the US.

3 Evidence on the frequency and size of price changes

In this section, we present evidence on the frequency and size of price changes in Switzerland from January 2008 to December 2022. We examine these characteristics of price-setting behavior in turn from an aggregate (Section 3.1), a cross-sectional (Section 3.2), and a time-series perspective (Section 3.3).

The frequency of price changes for variety v in month t is defined as

$$f_{v,t} = \frac{\sum_{p,s} \omega_{p,s,t} I_{p,s,t}}{\sum_{p,s} \omega_{p,s,t}}, \tag{1}$$

where $I_{p,s,t}$ is an indicator that takes the value 1 if the price of product p of variety v in outlet s has changed from the previous month $t-1$ and takes the value of 0 otherwise. The weight $\omega_{p,s,t}$ is calculated as the CPI share of variety v divided by the number of prices collected for that variety in month t. The frequency of price changes thus captures the share of prices that change in a given month. By analogy, we calculate the frequency of price increases, $f^+_{v,t}$, by considering only price increases in the price change indicator, $I^+_{p,s,t}$, and the frequency of price decreases, $f^-_{v,t}$, by considering only price decreases in the price change indicator, $I^-_{p,s,t}$. The aggregate frequency of price changes is the weighted average of frequencies at the variety level using CPI expenditure weights.

The average size of price changes, $\Delta p_{v,t}$, is defined as the mean of all non-zero log price changes. Absolute values of log price changes are used for the average absolute size of price changes, $|\Delta p_{v,t}|$. Similar to the analysis of the frequency of price changes, we also consider the size of price increases, Δp^+_t, and the size of price decreases, Δp^-_t. The aggregate size of price changes is the weighted average of the sizes at the variety level using CPI expenditure weights.

[9] In Table B.10 in the appendix, we discuss the sensitivity of our price-setting moments to alternative thresholds for trimming price changes in our data sample.

3.1 Aggregate perspective on the frequency and size of price changes

Table 2 provides average measures on the frequency and size of price adjustments from January 2008 to December 2022. To assess the sensitivity of our results to the treatment of temporary sales and product substitutions, the table also presents results for when we exclude these types of price changes from the data.

We first focus on our baseline sample, which includes temporary sales and product substitutions. The mean frequency of price changes is 26.2 percent. Hence, more than one in four prices change every month. This result suggests that price rigidity is a pervasive feature of consumer prices in Switzerland: prices are sticky and do not change continuously. Price increases (14.0 percent) are about as frequent as price decreases (12.2 percent). More than half of all price changes are price increases (55.8 percent). The median frequency of price changes (15.8 percent) is significantly lower than the mean, implying that the distribution of the frequency of price changes is right-skewed.[10] The standard deviation of variety-level adjustment frequencies is large (28.9 percent), which indicates considerable heterogeneity in the frequency of price changes.

The average absolute size of price changes is 11.1 percent from 2008 to 2022, with price increases averaging 10.4 percent and price decreases averaging 11.6 percent. The median absolute size of price changes is much smaller at 7.9 percent (with a median size of price increases of 7.0 percent and a median size of price decreases of 8.3 percent).[11] The distribution of non-zero price changes shows that the proportion of small price changes is large (see Table B.8 in the appendix). The mass of the distribution is centered around zero. Ten percent of all absolute price changes are smaller than 0.6 percent, and 25 percent are smaller than 1.6 percent. The large proportion of very small price changes is reflected in a kurtosis above 3 (standard normal distribution). The kurtosis of the standardized price changes is 5.2 and (5.6 if temporary sales are excluded, see Table B.9 in the appendix). Studies for other countries report similar values of kurtosis. For example, Vavra (2014) and Nakamura and Steinsson (2008) estimate the kurtosis at 4.9 and 5.1, respectively, in US CPI microdata.

Temporary price reductions due to sales contribute significantly to the frequency and size of price changes.[12] Price changes due to temporary sales are very frequent: 8.4 percent of all price changes are temporary sales. Temporary sales are highly seasonal and occur most frequently in January and July during winter and summer clearance sales, respectively.

We can calculate the frequency and size of price changes without sales prices by replacing any price identified as a sales price with the last non-sales price. As a result, the mean frequency of price

[10] Kaufmann (2009) reports a median frequency of price changes of 15.4 percent in Swiss CPI microdata from 2000 to 2005. However, this figure is not directly comparable to our result, as it is based on quarterly data and thus assumes that prices change at most once per quarter.

[11] Kaufmann (2009) reports a median absolute size of price changes of 13.6 percent in quarterly Swiss CPI microdata from 2000 to 2005. However, comparing this figure with our result does not carry much practical significance because it is based on quarterly data.

[12] Approximately 5.0 percent of all price quotes are flagged by the FSO as sales (see Table 1). Temporary sales are less frequent in Switzerland than in the US. Klenow and Kryvtsov (2008) find that approximately 11 percent of price records are sales, and Nakamura and Steinsson (2008) find a share of 7.4 percent. However, temporary sales are more frequent in Switzerland than in some euro-area countries. For example, 2.5 percent of the observations are related to temporary sales in France (Berardi et al., 2015). Nevertheless, the results may be influenced by the fact that national statistical offices apply different rules for classifying a price as a sales price.

changes drops by 2 percentage points from 26.2 percent to 24.2 percent (Table 2). The average absolute size of price changes declines by 3 percentage points from 11.1 percent to 8.3 percent. As shown in Appendix B.1, these results are not very sensitive to the method used to identify and filter temporary sales.[13]

In addition to temporary sales, product substitutions also have a significant influence on price-setting moments. Excluding price adjustments related to product substitutions lowers the average frequency of price changes by 2 percentage points to 24.3 percent.[14] By contrast, the average absolute size of price changes is only marginally smaller than in the baseline sample. While price increases are, on average, half a percentage point smaller (10.4 percent versus 9.8 percent), the size of price decreases is almost identical in the two samples (−11.6 percent versus −11.3 percent). This asymmetry is consistent with the view that firms use product replacements as an opportunity to impose higher prices.

We conclude our discussion of the average frequency and size of price changes by comparing our findings for Switzerland with evidence for the United States (based on Nakamura and Steinsson, 2008) and the euro area (based on Gautier et al., 2024). Comparing results with studies from other countries is inherently difficult because of differences in the composition of the consumption baskets. To make our two comparisons as consistent as possible, we attempt to restrict the samples in each comparison to the same equivalent products. Our results suggest that consumer prices in Switzerland are more flexible than the euro area average but about as flexible as those in the United States (if we disregard price changes related to temporary sales in comparison with the United States). With respect to the size of price changes, we find that price changes in Switzerland are significantly smaller than in the US but slightly larger than in the euro area, which holds irrespective of the treatment of temporary sales. We provide further details on the comparison method and the results in Appendix B.6 for the comparison with the United States and in Appendix B.7 for the comparison with the euro area.

3.2 Cross-sectional perspective on the frequency and size of price changes

There is substantial cross-sectional heterogeneity in the frequency and size of price changes. Table B.15 in the appendix shows the average frequency of price changes for the food, non-energy industrial goods (NEIG), energy, and services sectors and their subcategories. Table B.16 in the appendix summarizes the average size of price changes in each sector.

Prices of energy products are adjusted most frequently (mean frequency of 87.0 percent), while prices of services are adjusted least frequently (16.8 percent). This large difference is likely due to variations in the volatility of input prices. Prices of energy products, such as those for fuel or heating oil, are

[13] We assess the robustness of our results to alternative sales filters by applying the symmetric V-shaped filter proposed by Nakamura and Steinsson (2008) and the running mode filter proposed by Kehoe and Midrigan (2015). Table B.1 in the appendix shows that the mean frequency of price changes is 24.0 percent and 19.5 percent if the price data are filtered by the V-shaped sales filter with a 1-month and 3-month window, respectively, and 22.7 percent if the data are filtered by the running-mode filter with a 3-month window. Except for the case of the V-shaped filter with a 3-month window, these results are close to those reported in Table 2 (26.2 percent), where temporary sales are identified by the FSO sales flags.

[14] Studies using US data find similar effects: excluding product substitutions reduces the mean frequency of price changes from 27.7 percent to 26.5 percent (Nakamura and Steinsson, 2008) and from 26.1 percent to 23.6 percent (Bils and Klenow, 2004).

influenced not only by the global crude oil market but also by exchange rate movements—both of which can fluctuate daily and often significantly. By contrast, one of the largest input factors for many services is labor, which is typically governed by long-term contracts and remains relatively stable in the short run.

Among food products, the mean frequency of price changes for unprocessed foods (45.6 percent) is twice as large as that for processed foods (23.9 percent). Again, the high frequency of price changes for unprocessed food is likely due to the strong dependence of these prices on world market prices and exchange rates. Similarly, the frequency of price changes for durable goods (18.6 percent) is almost twice as large as that for non-durable goods (12.9 percent). The relatively high frequency of price changes for both unprocessed food and durable goods might stem from the fact that they are often sold in highly competitive retail markets with narrow profit margins.

Average absolute price changes are largest for NEIG (16.7 percent) and smallest for energy products (2.8 percent). The average absolute size of price changes for food and services is 8.3 percent and 12.7 percent, respectively. In all sectors, price decreases are slightly larger than price increases. The median results show the same patterns.

3.3 Time-series perspective on the frequency and size of price changes

We conclude this section by presenting time-series evidence on the frequency and size of price changes. Figure 1 illustrates the cross-sectional distributions of the frequency of price changes (in the top panel) and the absolute size of price changes (in the bottom panel) from January 2008 to December 2022. For each month, the figure shows the mean, the median, the interquartile range (dark-shaded area), and the 15th–85th percentile range (light-shaded area) of the frequency and size of price changes calculated across varieties.

Figure 1 reveals significant changes in price-setting behavior over time. For one, both the frequency and the size of price changes exhibit considerable high-frequency variations. Some of these are seasonal, while others may be due to macroeconomic shocks. For example, the substantial increase in the frequency of price changes in early 2015 most likely reflects the effect of the marked Swiss franc appreciation following the decision of the Swiss National Bank (SNB) to discontinue the minimum exchange rate for the Swiss franc against the euro.[15]

In addition to these high-frequency fluctuations, we also uncover low-frequency changes in price-setting behavior. These are particularly evident in the evolution of the frequency of price changes, whereas the size of price changes shows little variation over time.

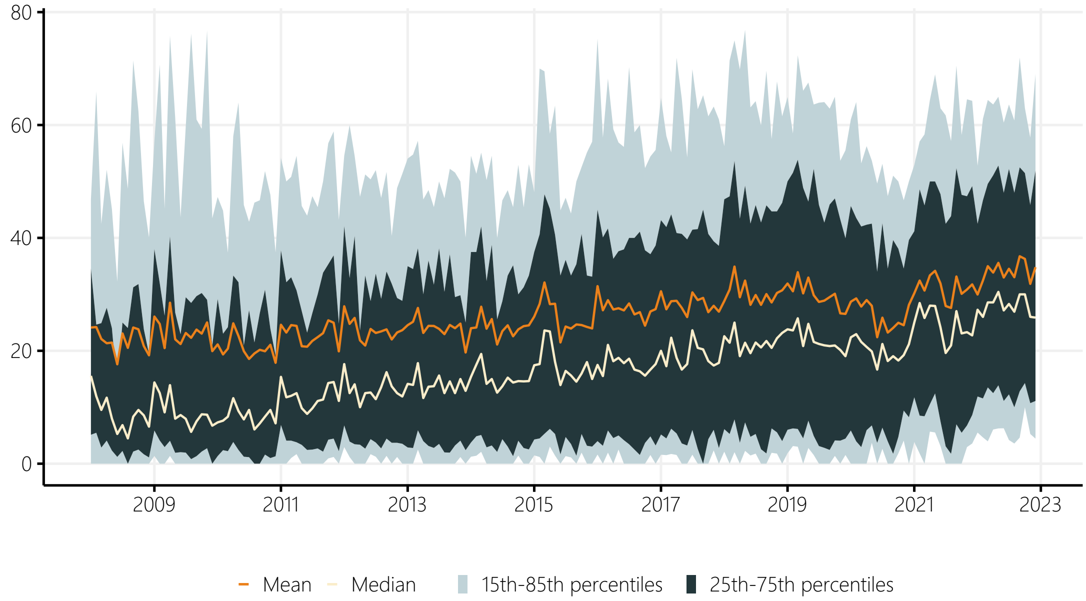
The period *before*[16] the pandemic (from January 2008 to January 2020) is characterized by a continuous increase in the frequency of price changes. It averages 21.9 percent in 2008 and 30.0 percent

[15]The SNB enforced a minimum exchange rate of 1.20 CHF per euro from 6 September 2011 to 15 January 2015. After the discontinuation of the minimum exchange rate floor, the Swiss franc appreciated sharply before stabilizing at approximately 1.10 CHF per euro in 2015 and 2016.

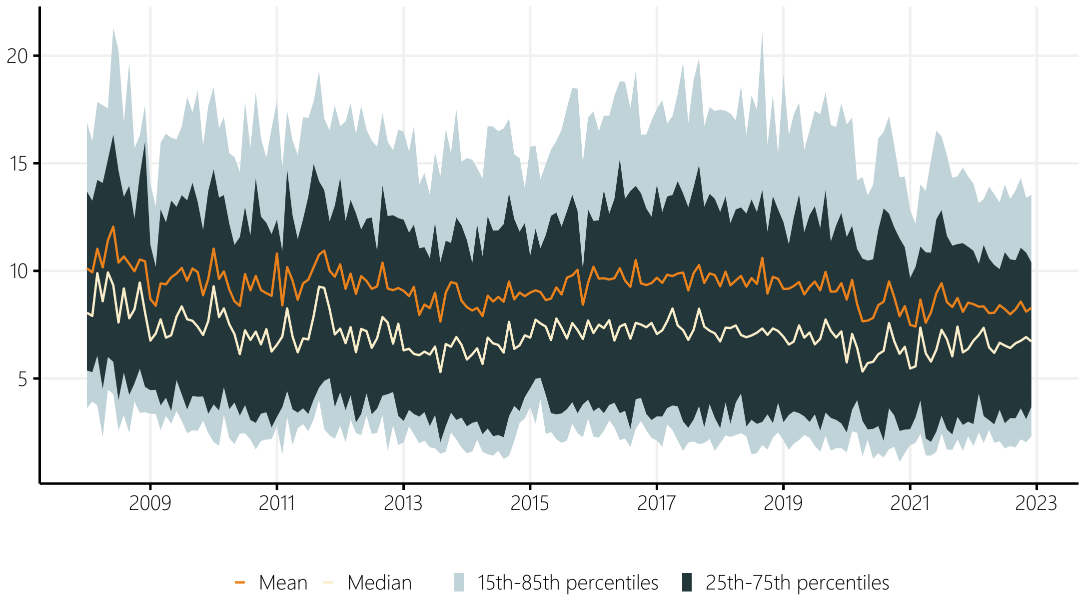
[16]In distinguishing between the periods before and during the pandemic, we follow the definition of the World Health Organization (WHO) that declared a public health emergency of international concern (PHEIC) related to COVID-19 on 30 January 2020 and lifted its PHEIC on 5 May 2023.

Figure 1: Distribution of the frequency and absolute size of price changes across varieties over time

Frequency of price changes



Absolute size of price changes



Notes: Distribution of the frequency (top panel) and absolute size (bottom panel) of price changes across varieties in Swiss CPI microdata over time. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. The figure depicts the mean, the median, the interquartile range (dark-shaded areas), and the 15th-85th percentile range (light-shaded areas). Moments are reported in percent per month.

in 2019. At the same time, the interquartile range of price adjustment frequencies widens over time. In particular, the 75th percentile increases more than the 25th percentile.

The period *during* the pandemic (from February 2020 to the end of our sample in December 2022) initially shows a trend reversal, accompanied by a narrowing of the distribution, which is then followed by a renewed increase in the frequency of price adjustments. Unlike the pre-pandemic period, however, this increase is broad-based: We observe not only an increase in the upper percentiles but an upward shift in the entire distribution of price adjustment frequencies.

Motivated by these observations, we examine price setting separately for each period in the following two sections to gain a more detailed understanding of the respective characteristics and their underlying drivers.

4 Price setting before the pandemic

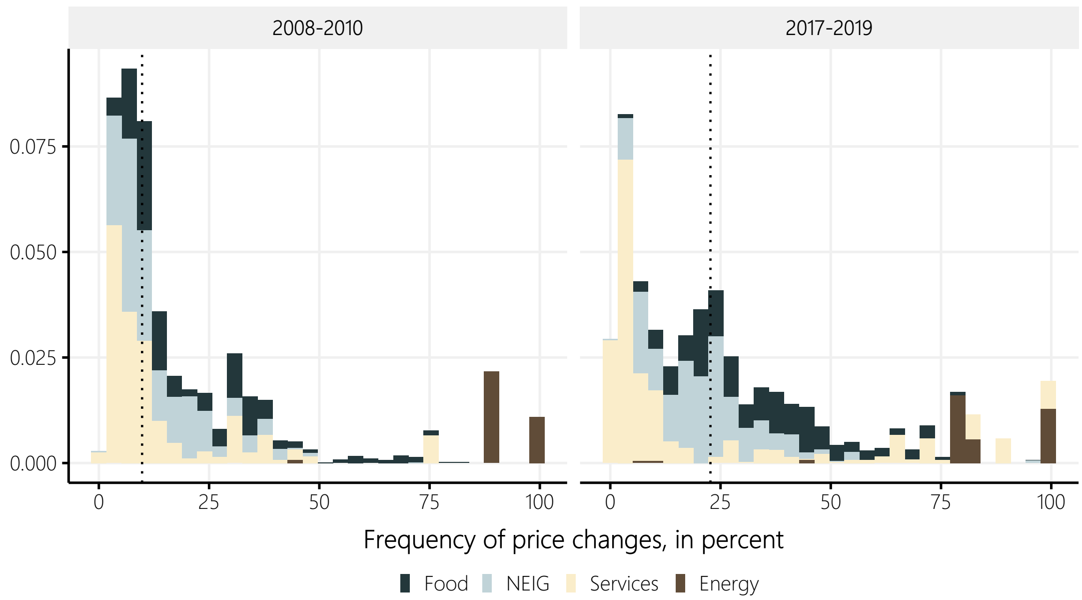
The most prominent feature of price setting in the period before the pandemic is the increase in the average frequency of price changes uncovered in Figure 1. The average frequency of price changes increases slightly but steadily from 21.9 percent in 2008 to 30.0 percent in 2019, implying that price changes have become more flexible on average. This trend is driven equally by more frequent price increases and decreases (see Figure C.1 in the appendix). At the same time, there is no trend in the absolute size of price changes: It was 10.6 percent in 2008 and 9.3 percent in 2019.[17] The sizes of price increases and decreases also show no trend (see Figure C.2 in the appendix).

The interquartile range of price adjustment frequencies widens over time. In particular, the 75th percentile increases more than the 25th percentile. This suggests that the increase in the average frequency is not the result of a broad-based tendency toward more frequent price changes but of a marked increase in price adjustment frequencies in a subset of the CPI. To illustrate which components of the CPI are responsible for this increase in the overall frequency of price adjustment, Figure 2 shows the distribution of item-level frequencies for four sectors (food, NEIG, services, and energy) over the periods 2008 to 2010 and 2017 to 2019.

The comparison of the sectoral distributions shows that the frequency of price changes increased most visibly in the food and NEIG sectors. On average, it climbed from 20.2 percent to 33.3 percent for food items and from 11.9 percent to 19.8 percent for NEIG (see Table B.6 in the appendix). This increase is substantial, as both sectors account for more than half of our sample by expenditure weight. For services, we note a marked increase at both tails of the distribution. Nevertheless, the average frequency of price changes for services increased substantially from 12.5 percent in the period 2008 to 2010 to 23.3 percent in the period 2017 to 2019. At the same time, the average frequency of price changes declined for energy goods (from 92.4 percent to 83.2 percent).

[17] These findings are robust to alternative data treatments (e.g., the exclusion of temporary sales or product substitutions), methodological changes in price collection (i.e., changes in the basket composition, changes in the price collection frequency, or the introduction of scanner data), and the use of constant rather than time-varying basket weights when aggregating item-level frequencies of price changes (see Figure B.1 in the appendix). Furthermore, we find that the increase in the frequency of price changes is not the result of an increase in the number of goods sold per outlet (see Figure B.2 in the appendix).

Figure 2: Distribution of item-level frequencies of price changes



Notes: Distribution of the frequency of price changes across expenditure items from January 2008 to December 2010 (left panel) and from January 2017 to December 2019 (right panel). The samples include price changes due to temporary sales and product substitution. Contributions of sectors (food, goods, services, and energy) are weighted by constant CPI expenditure weights across periods. The vertical dotted lines show the median frequency of price changes.

Among the products with the largest increase in price adjustment frequencies are those for which e-commerce has become a major retail channel over the last decade. In Switzerland, sales in online and mail-order business more than doubled from CHF 5.1 billion in 2010 to CHF 10.3 billion in 2019, while retail sales in brick-and-mortar stores declined from CHF 91.1 billion to CHF 81.3 billion over the same period.[18] The online share varies considerably across product groups. By far, consumer electronics account for the largest share. In 2010, approximately 15 percent of all consumer electronics items were sold over the internet. In 2019, the share amounted to 36 percent.

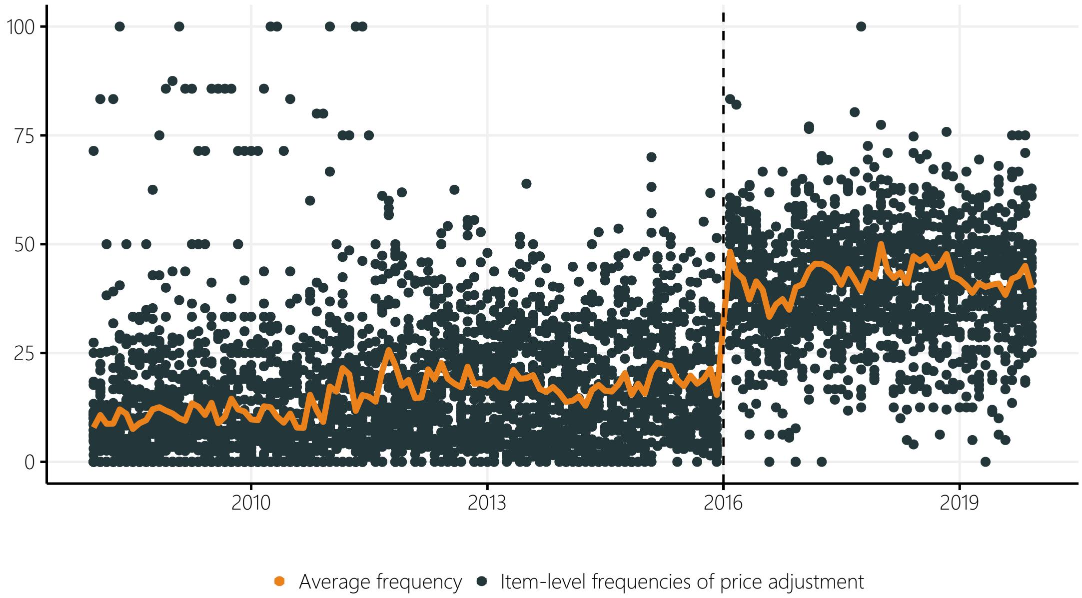
The FSO accounts for these changes in consumer behavior and shopping habits of Swiss households by collecting an increasing share of prices online. Since January 2016, the prices of consumer electronics have been collected exclusively via the internet.[19] Figure 3 illustrates the effect of the methodological change in the collection of consumer electronics prices on their frequency of price changes. With the transition to online price collection in January 2016, the frequency of price changes more than doubled. This discontinuity indicates that price-setting behavior differs greatly depending on the sales channel (online versus stationary retail).

A similar picture emerges when we decompose the frequency of price changes by the mode of price

[18] The data are assembled as part of the overall market survey for online retail in Switzerland by HANDELSVERBAND.swiss together with GfK and in cooperation with Swiss Post (HANDELSVERBAND.swiss, 2022).

[19] Consumer electronics includes the following items: telecommunication equipment; television sets; audiovisual appliances; photographic, cinematographic equipment and optical instruments; IT peripheral devices and accessories; computer software; storage devices and contents; games, toys and hobbies; and game consoles and electronic games.

Figure 3: Discontinuity in the frequency of price changes for consumer electronics between prices collected in-store (before 2016) and online (since 2016)



Notes: Item-level frequencies of price adjustments of consumer electronics items. The sample ranges from January 2008 to December 2019 and includes price changes due to temporary sales and product substitution. The prices of consumer electronics items have been collected exclusively via the internet since January 2016 (and were collected previously in regular outlets and only partially online). The frequencies are reported in percent per month.

collection: items collected exclusively online—where price collection has shifted to "fully online"[20], items collected "partially online"—where online prices have been introduced alongside continued in-store price collection[21], and "offline" items, for which prices are still collected exclusively in physical stores (accounting for 44.6 percent of CPI expenditures, on average), as in Figure C.3 in the appendix.

Items for which price collection has completely switched to online show a significant increase in the frequency of price changes. It increased from 17.9 percent in 2008 to 73.8 percent in 2019. The average frequency of price adjustments has also increased for partially online items, albeit to a lesser extent, increasing from 17.0 percent in 2008 to 23.7 percent in 2019. This increase is particularly noticeable from 2015 onward, coinciding with the CPI revision that accelerated the transition to online price collection (FSO, 2016). By contrast, the trend almost disappears for the frequency from which online items are excluded. Compared to the baseline, the increase is considerably muted, rising from 22.1 percent in 2008 to 26.0 percent in 2019, indicating that the broader trend was primarily driven by the shift toward online price collection.

The decomposition highlights one important channel through which e-commerce affects the average

[20] Items collected "fully online" include garden maintenance, other services relating to the dwelling, consumer electronics, air transport, international and domestic package holidays, mountain railways, ski lifts, second-hand cars, and social protection services (FSO, 2016, 2022). These items account for 5.0 percent of CPI expenditure weights, on average.

[21] Items collected "partially online" include items of the product groups clothing, footwear, furniture, and furnishings (FSO, 2016). These items account for 5.7 percent of CPI expenditures, on average.

frequency of price changes: the rising share of online prices in the CPI microdata. Another channel is the effect of the rise of e-commerce on the price-setting behavior of stationary retailers. Because stationary retailers and online platforms compete with each other, the higher frequency of changes in online prices is likely to affect the price-setting behavior of stationary retailers as well. Cavallo (2018a) provides evidence that prices of goods that can easily be found on Amazon tend to be adjusted more frequently. He concludes that these results are consistent with intense online competition characterized by low margins, dynamic pricing technologies, and price transparency on the internet. Rudolf and Seiler (2022) examine this channel in Swiss CPI microdata and estimate a fixed-effects panel data model using a proxy measure for average profit margins per expenditure items. They find that profit margins have a statistically significant negative effect on the frequency of price changes, which is consistent with the view that the rise of e-commerce, by increasing competition and reducing profit rates, positively affected the frequency of price adjustments.

The evaluation of the frequency of price adjustments in the period before the pandemic suggests that the increasing consideration of prices from online markets contributed to the observed increase in the overall frequency of price changes. Earlier studies found related results in other datasets. Using web-scraped prices from multi-channel retailers in the US, Cavallo (2018a) documents that the aggregate frequency of price changes increased between 2008 and 2017. Gorodnichenko and Talavera (2017) and Gorodnichenko et al. (2018) show that prices in online marketplaces are far more flexible than the micro prices collected in stores. By uncovering similar trends in our data, we document the role of online retailing as a source of greater price flexibility in micro price data underlying a national CPI.

5 Price setting during the pandemic

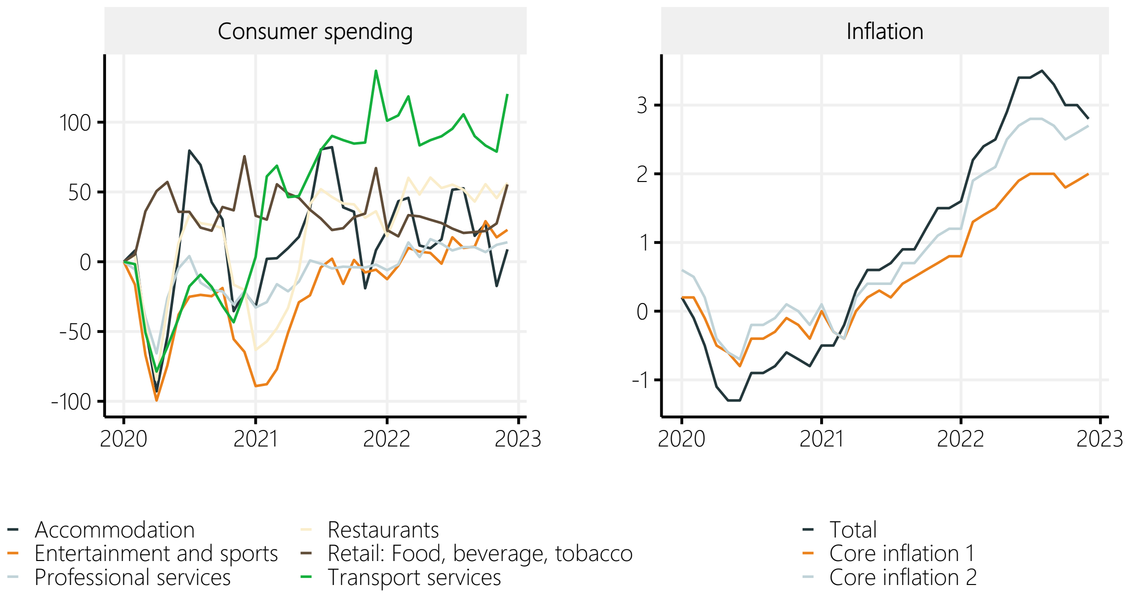
The spread of the coronavirus disease (COVID-19) in early 2020 triggered an economic crisis that affected all countries, including Switzerland.[22] To contain the pandemic, the federal government imposed a range of measures such as temporary lockdowns, travel restrictions, and social distancing rules. These measures severely restricted business operations and consumer spending. The left panel of Figure 4 shows year-on-year changes in Swiss debit card transaction volumes, which can be viewed as an approximation of consumer spending.[23]

According to these data, private consumption declined sharply in spring 2020 and, to a lesser extent, in late autumn 2020. However, the effect of the pandemic varied widely across sectors. Spending in service sectors such as entertainment and sports, accommodation, or restaurants took the largest hit and recovered only slowly thereafter. By contrast, spending on food, beverages and tobacco recorded higher sales throughout 2020 than in the previous year. In most other categories, consumption

[22] The virus was confirmed to have reached Switzerland on 25 February 2020, when a person tested positive for COVID-19 for the first time. Faced with a rapidly deteriorating epidemiological situation, the federal government decreed a partial lockdown and introduced nationwide measures to protect the public on 16 March. These measures were gradually removed from late April until June 2020. However, as COVID-19 cases surged again in October 2020, the authorities reimposed some measures towards the end of the year.

[23] These data are based on debit card transactions issued by banks to their customers in Switzerland and include point-of-sales debit card payments (Brown et al., 2023). Baker et al. (2020) for the US or Carvalho et al. (2021) for Spain use similar data to assess the impact of the containment measures on consumer demand.

Figure 4: Consumer spending and inflation during the pandemic



Notes: Changes in Swiss consumer spending and inflation during the pandemic from January 2020 to December 2022. The left panel shows changes in debit card transaction volumes relative to January 2020 in percent. The right panel shows year-on-year changes in the Swiss consumer price index in percent. "Core inflation 1" refers to the total index without fresh and seasonal products, energy and fuels. "Core inflation 2" refers to core inflation 1 without products whose prices are administered.

spending declined significantly in spring 2020 but recovered or even increased above previous-year levels in the months that followed.

At the same time, CPI inflation declined during the lockdown, reaching -1.3 percent in May and June 2020, as shown in the right panel of Figure 4. After this initial decline, however, inflation rose rapidly as the pandemic progressed. It peaked at 3.5 percent in August 2022, a rate last seen in Switzerland in the early 1990s. Various factors have increased inflationary pressures during the pandemic. These include pent-up demand triggered by the easing of pandemic-related restrictions, disruptions in global supply chains, which led to bottlenecks and delays in the availability of goods and raw materials, and the Russian invasion of Ukraine in early 2022, which pushed up energy prices across Europe.

In this section, we examine price setting during the COVID-19 pandemic. We compare the frequency and size of price changes with their pre-crisis values (Section 5.1) and analyze the behavior of temporary sales (Section 5.2). The analysis uses our baseline sample, which includes price changes due to temporary sales and product substitution but excludes COVID imputations.

5.1 The frequency and size of price changes during the pandemic

We begin by analyzing the effect of the pandemic on the frequency and size of price changes.[24] Figure 5 shows the frequency and the size of price changes from January 2020 to December 2022, first for all price changes (in the top row) and then separately for price increases (in the middle row) and price decreases (in the bottom row). To indicate the pre-pandemic levels, the dashed lines show the respective average values calculated from January 2018 to December 2019, and the shaded areas indicate the dispersion measured as the standard deviation around the mean over the same period.

After the outbreak of the pandemic in early 2020, the frequency of price changes fell below its pre-pandemic level. In 2020, it averaged 23.5 percent, a difference of 4.4 percentage points compared to the pre-pandemic level. Both the frequency of price increases and decreases contributed to the overall slowdown in the frequency of price changes in 2020. However, while the frequency of price decreases remained below its average level of the previous two years throughout most of the pandemic, the frequency of price increases picked up significantly in early 2021 and 2022. It averaged 17.5 percent in 2021 and 18.7 percent in 2022, well above its pre-pandemic average of 14.8 percent. This may be due to the improvement of the epidemiological situation. The pandemic-related restrictions were lifted, and consumer demand recovered, creating a favorable environment for firms to increase prices.

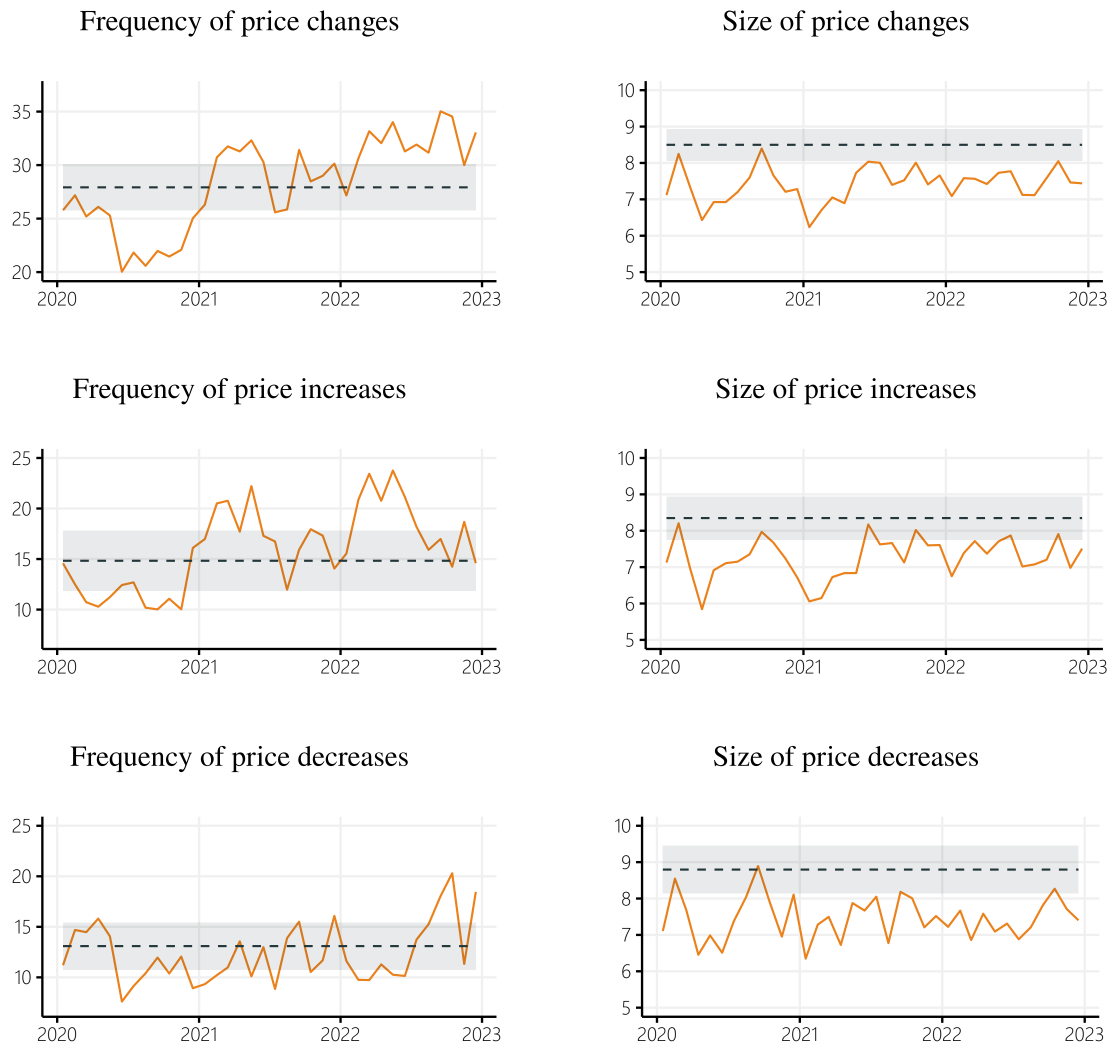
The price changes were smaller every month during the pandemic than in the previous two years. The average absolute size of price changes was 7.4 percent during the pandemic, 1.1 percentage points less than in the two years prior to the pandemic. Both the size of price increases and decreases became smaller. The decline was particularly pronounced in April 2020 and February 2021, largely coinciding with the progression of infection and the surge in the number of COVID-19 cases.

5.2 The frequency and size of sales during the pandemic

To examine the behavior of temporary sales during the COVID-19 pandemic, we consider the frequency and size of sales from January 2020 to December 2022. There is a long and ongoing debate about whether firms use temporary sales to adjust to aggregate shocks. On the one hand, Eichenbaum et al. (2011) argue that high-frequency price movements should be filtered out of the data used to analyze macroeconomic responsiveness because a menu cost model calibrated to match the frequency of reference price changes does better at reproducing the effects of a monetary policy shock than a version of the same model in which the size of the menu cost is fitted to the frequency of posted price changes. In the same vein, Anderson et al. (2017) find that sales are insensitive to wholesale cost shocks in data from a US retailer selling general merchandise and groceries. On the other hand, Klenow and Willis (2007) find evidence in US CPI microdata that sales-related price changes respond similarly to macro information as regular price changes. In addition, Kryvtsov and Vincent (2021) demonstrate that the frequency of sales is strongly countercyclical, more than doubling during the Great Recession.

[24] We provide evidence on the cross-sectional heterogeneity in the frequency and size of price changes during the pandemic in Appendix D.1.

Figure 5: Frequency and size of price changes, increases, and decreases during the pandemic

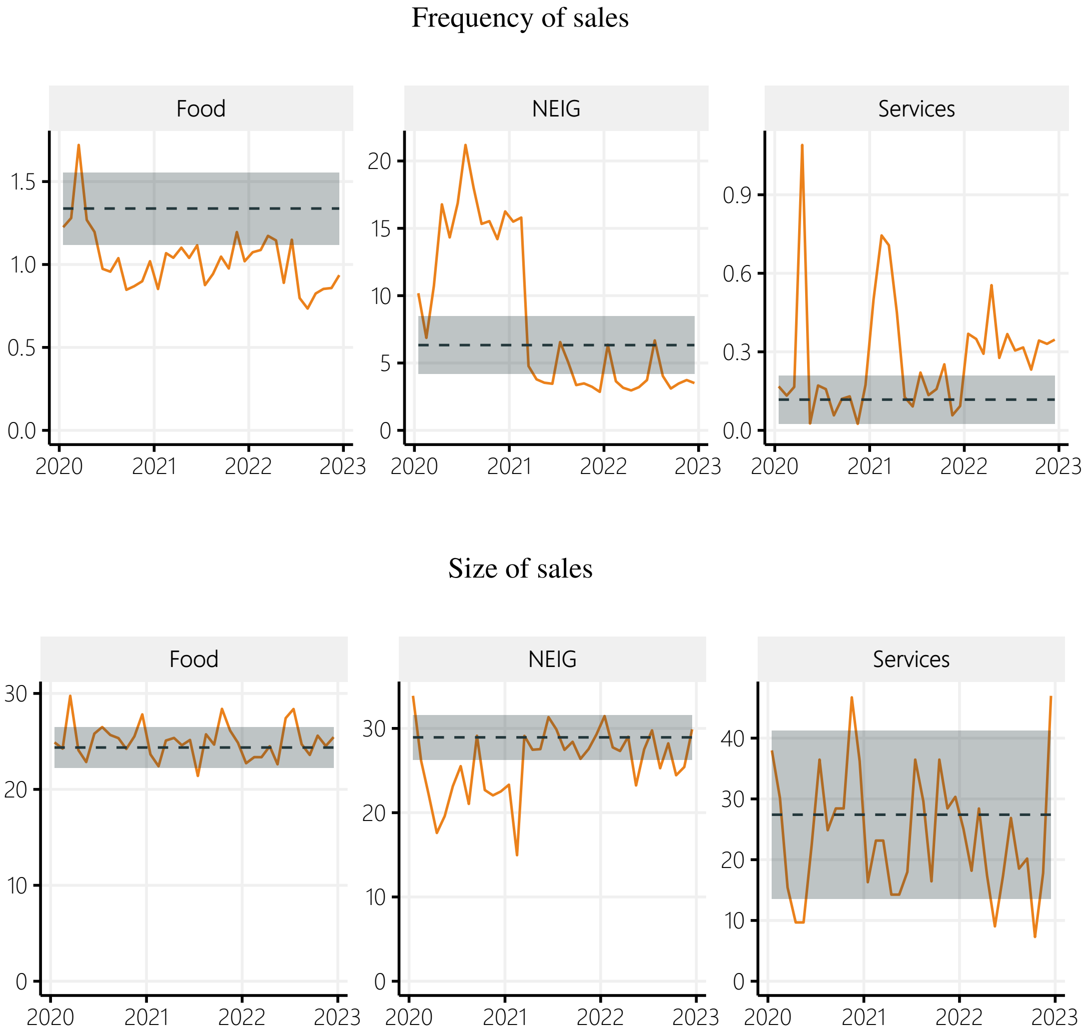


Notes: This figure shows the frequency of price changes (in the top left panel), price increases (in the middle left panel), and price decreases (in the bottom left panel), and the absolute size of price changes (in the top right panel), price increases (in the middle right panel) and absolute price decreases (in the bottom right panel) during the pandemic from January 2020 to December 2022. The shaded areas show the mean of the respective measures from January 2018 to December 2019 and the dispersion measured as the standard deviation around the mean (resulting in two-standard-deviation bands). The sample includes temporary sales and product substitutions but excludes COVID imputations. All moments are reported in percent per month.

We calculate the frequency of sales as the share of sales prices as identified by the FSO sales flag and aggregate them using CPI expenditure weights for each variety and month. Similarly, we compute the size of sales in a given month as the average absolute difference between log sales prices and their corresponding regular prices, weighted accordingly. Figure 6 illustrates the frequency of sales and the size of sales across sectors. The dashed lines show the respective average values over the sample from January 2018 to December 2019. The shaded areas represent the values that are within two standard deviations of the mean.

The results in the top panels of Figure 6 show that discount policies varied strongly across sectors

Figure 6: Frequency and size of sales during the pandemic



Notes: The frequency of sales (in the top panels) and the (absolute) size of sales (in the bottom panels) across sectors during the pandemic from January 2020 to December 2022. The shaded areas show the mean of the respective measures from January 2018 to December 2019 and the dispersion measured as the standard deviation around the mean (resulting in two-standard deviation bands). The sample includes temporary sales and product substitutions but excludes COVID imputations. All moments are reported in percent per month.

already before the pandemic. Between January 2018 and December 2019, an average of 6.3 percent of all NEIG prices were temporarily discounted. By contrast, temporary sales played virtually no role in services (0.1 percent) and accounted for only a small share of food prices (1.3 percent).

Following the outbreak of the pandemic, the frequency of temporary sales increased significantly for NEIG. It amounted to 14.7 percent on average in 2020, which is more than double the pre-pandemic level. In July 2020, more than 20 percent of all NEIG prices were sales prices. From 2021 onwards, the frequency of sales declined again, falling below its pre-pandemic average at 4.9 percent. Also, for services, we find that the frequency of sales increased by a factor of 3 to 0.3 percent on average during the pandemic. By contrast, the frequency of sales decreased in the food sector, where demand increased with the pandemic. It dropped to 1.1 percent, on average, from January 2020 to December

2022, which corresponds to a decline of one-fifth compared to the pre-pandemic level. This decline is in line with findings of Henkel et al. (2023), who show that supermarket retailers in Germany and Italy responded to the positive demand shock following the outbreak of the pandemic by reducing the frequency of temporary sales.

The lower panels of Figure 6 show the size of temporary price discounts across sectors. In 2020, discounts for NEIG were smaller than in the previous two years. From March 2020 to May 2021, the size of sales-related price changes was 22.9 percent on average and thus 6.0 percentage points smaller than in the two years prior to the pandemic. Retailers of NEIG appear to have cushioned the large losses of revenues during the lockdown with smaller but more frequent temporary sales. For food and services, we find no significant change in the size of temporary discounts.

Taken together, the evidence on the frequency and size of temporary sales during the COVID-19 pandemic suggests that retailers adjust their use of temporary sales to macroeconomic shocks. In particular, the frequency of sales displayed a strongly countercyclical pattern in response to the pandemic. This finding contributes to the literature highlighting the responsiveness of temporary sales to aggregate shocks (e.g., Klenow and Willis, 2007; Kryvtsov and Vincent, 2021).

6 Price-setting behavior and inflation dynamics

Inflation is the result of individual decisions to adjust prices: inflation can change because more firms change their prices or because firms change their prices by a larger amount. This section analyzes how the frequency and the size of price changes contribute to variations in inflation (Section 6.1) and how these price-adjustment components shape the response of inflation to aggregate shocks (Section 6.2).

6.1 Contributions of the frequency and size of price changes to variations in inflation

Following Klenow and Kryvtsov (2008) or Wulfsberg (2016) we express the monthly item-level inflation rate as

$$\pi_{i,t} \approx \hat{\pi}_{i,t} = f_{i,t} \cdot \Delta p_{i,t}, \tag{2}$$

where $f_{i,t}$ is the frequency of price changes of expenditure item i in month t and $\Delta p_{i,t}$ is the size of non-zero monthly price changes of item i. The variable $\hat{\pi}_t$ is an approximation and not an exact representation of the monthly CPI inflation rate π_t for two main reasons. First, our sample is restricted and does not include administered prices and prices based on unit value indices. Second, our weighting procedure relies solely on item weights from the basket of goods and services, without the additional stratification by regions and distribution channels applied in the calculation of the CPI (FSO, 2016).

Using the decomposition in Equation (2), we construct two counterfactual estimates of CPI inflation to assess the contributions of the frequency and size of price changes to variations in inflation. The two estimates differ in that we allow either the frequency or the size of price changes to vary over time while holding the other constant at its item-specific mean. The frequency-related inflation rate, holding the size of price changes constant at Δp_i, is:

$$\hat{\pi}_{i,t}|_{\Delta p} = f_{i,t} \cdot \Delta p_i. \tag{3}$$

All variation in $\hat{\pi}_{i,t}|_{\Delta p}$ is due to variation in the frequencies of price changes. This case is consistent with predictions of a state-dependent model in which firms respond to shocks through the probability (but not the size) of price adjustments.

Similarly, holding the frequency of price changes constant at f_i, the size-related inflation rate is:

$$\hat{\pi}_{i,t}|_{f} = f_i \cdot \Delta p_{i,t}. \tag{4}$$

All variation in $\hat{\pi}_{i,t}|_{f}$ is due to variation in the size of the price changes. This case is consistent with predictions of a pure Calvo (1983) model in which the probability of price changes is constant over time, and variation in inflation comes only from fluctuations in the size of price changes.

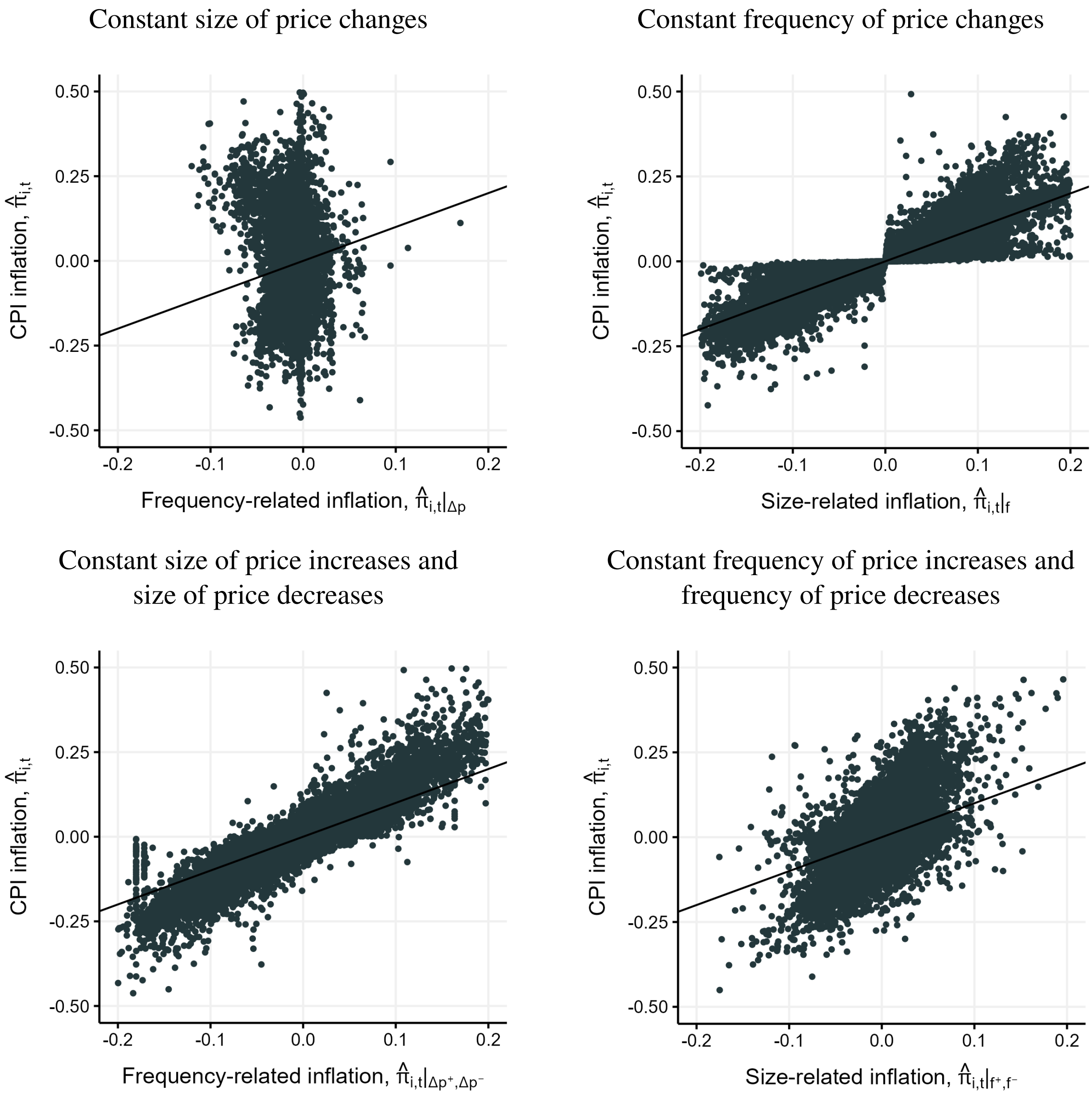
Table 3 shows the correlation coefficients between monthly item-level inflation rates calculated from CPI microdata and the counterfactual inflation rates calculated based on Equation (3) and Equation (4). The table shows that the correlation coefficient between inflation and the size-related inflation rates, $\hat{\pi}_t|_f$, is 0.84, with sectoral coefficients ranging between 0.72 and 0.98. This correlation is much stronger than the correlation between inflation and the frequency-related inflation rates, $\hat{\pi}_t|_{\Delta p}$, for which we obtain a correlation coefficient of 0.12, ranging from 0.02 to 0.27 at the sectoral level.

Figure 7 visualizes these results. The top-left panel shows the frequency-related inflation, $\hat{\pi}_{i,t}|_{\Delta p}$, of each item i and month t plotted against the corresponding month-on-month inflation rate, while the top-right panel presents a plot of the size-related inflation, $\hat{\pi}_{i,t}|_f$, against the corresponding month-on-month inflation rate. The straight lines indicate the 45-degree lines in both graphs. When we hold the frequencies of price changes constant at their item-specific means (top-right panel), the counterfactual inflation estimates align more closely with the 45-degree line than when we hold the size of price changes constant (top-left panel).

Overall, our results suggest that variations in inflation are dominated by variations in the size of price changes. This lends some support to the Calvo (1983) model. However, the Calvo model predicts that price adjustment frequencies are constant over time and thus cannot contribute to the variation in inflation at all. In state-dependent pricing models, by contrast, variations in the frequency of price changes account for some of the variations in inflation. Variations in the frequency of price changes appear to be a modest source of inflation variability in Swiss CPI microdata. This result is in line with findings obtained by Klenow and Kryvtsov (2008) for the US and Gautier et al. (2024) for the euro area but contrasts with findings by Gagnon (2009) for Mexico.

We can further investigate the contributions of the frequency and size of price changes to inflation variations by distinguishing between price increases (+) and price decreases (−). In this case, the inflation rate can be written as

Figure 7: Contributions of the frequency and size of price changes, increases, and decreases to inflation variations



Notes: The figure shows scatter plots between inflation, as in Equation (5), and counterfactual inflation rates, as in Equation (3), Equation (4), Equation (6), and Equation (7). The straight lines indicate the 45-degree line. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. A value of 0.1 corresponds to 10 percent.

$$\hat{\pi}_{i,t} = f^+_{i,t} \cdot \Delta p^+_{i,t} + f^-_{i,t} \cdot \Delta p^-_{i,t}, \tag{5}$$

where $f^+_{i,t}$ and $f^-_{i,t}$ are the frequency of price increases and the frequency of price decreases and $\Delta p^+_{i,t}$ and $\Delta p^-_{i,t}$ are the average size of price increases and the average size of price decreases of item i in month t. We consider two counterfactual inflation rates based on Equation (5). The first, $\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$, is similar to the frequency-related inflation, but instead of holding the size of price changes constant, both the size of price increases and the size of price decreases are held constant over time:

$$\hat{\pi}_{i,t}|_{\Delta p^{+},\Delta p^{-}} = f^{+}_{i,t} \cdot \Delta p^{+}_{i} + f^{-}_{i,t} \cdot \Delta p^{-}_{i}. \tag{6}$$

The second counterfactual inflation rate, $\hat{\pi}_{i,t}|_{f^{+},f^{-}}$, assumes that the frequency of both price increases and decreases is constant over time:

$$\hat{\pi}_{i,t}|_{f^{+},f^{-}} = f^{+}_{i} \cdot \Delta p^{+}_{i,t} + f^{-}_{i} \cdot \Delta p^{-}_{i,t}. \tag{7}$$

Thus, the variation in $\hat{\pi}_{i,t}|_{\Delta p^{+},\Delta p^{-}}$ is due to the variation in the frequencies of price increases and price decreases, while the variation in $\hat{\pi}_{i,t}|_{f^{+},f^{-}}$ is due to the variation in the size of price increases and price decreases.

The results based on Equation (6) and Equation (7) are summarized in Table 3. The correlation coefficient between inflation and counterfactual inflation assuming constant sizes of price increases and decreases is 0.78, with a range of 0.70 to 0.86 across sectors. This correlation is significantly stronger than the correlation between inflation and counterfactual inflation assuming constant frequencies of price increases and price decreases. In the latter case, the correlation coefficient is 0.59, with a range of 0.50 to 0.69 for the sectors. Figure 7 presents a graphical representation of the results. The scatterplots indicate a positive relationship between time variations in inflation and the contributions of both the time variations in the frequency of price increases and decreases (bottom-left panel) and the time variations in the size of price increases and decreases (bottom-right panel).

What stands out in Figure 7 is the stark contrast between the top-left panel and the bottom-left panel. Time variations in the frequency of price increases and decreases contribute significantly to the time variations in inflation (bottom-left panel), while time variations in the frequency of all price changes do not. The reason is that the frequency of price increases tends to go up when the frequency of price decreases goes down, and vice versa. As a result, the frequency of all price changes is fairly stable, which keeps the contribution from time variations in the frequency of price changes low.

Thus, when considering positive and negative price changes separately, the analysis suggests that the variation in inflation is slightly more strongly driven by changes in the frequencies of price increases and decreases than by changes in the sizes of price increases and decreases. Gautier et al. (2024) for the euro area and Wulfsberg (2016) for Norway obtain similar results for micro prices underlying the respective CPIs.

6.2 Response of price setting and inflation to aggregate shocks

This section analyzes how counterfactual inflation rates respond to various aggregate shocks in order to identify the margins of price adjustment that drive the inflation responses. Using the local projections regression framework introduced by Jordà (2005), we estimate the dynamic effects of four distinct aggregate shocks, S_t, as identified in the literature: oil supply news shocks (Känzig, 2021), global demand shocks (Baumeister and Hamilton, 2019), Swiss franc safe haven shocks (Boneva, 2024), and monetary policy shocks (Nitschka and Oktay, 2023).[25] The analysis proceeds in two steps. First, we employ linear local projections to estimate the average inflation responses to the shocks, assuming homogeneity in their transmission (Section 6.2.1). This approach closely follows Gautier et al. (2024). Second, we extend the framework to nonlinear local projections to account for potential state dependence in the transmission of the shocks, allowing for time variation in price-setting moments and aggregate price flexibility (Section 6.2.2).

6.2.1 Linear local projections

For each shock, S_t, the estimated linear local projections model is:

$$\pi^*_{i,t-1,t+h} = \alpha_{i,h} + \alpha_{m,h} + \beta_h S_t + \gamma_h X_t + \varepsilon_{i,t_h} \tag{8}$$

where $\pi^*_{i,t-1,t+h}$ represents the cumulated inflation rate for item i between periods $t-1$ and $t+h$, $\alpha_{i,h}$ are item fixed effects, $\alpha_{m,h}$ are month fixed effects, and ε_{i,t_h} are i.i.d. error terms. In all versions of this equation, X_t includes one lag of monthly changes in industrial production[26] and in the exchange rate of the Swiss franc against the euro as control variables. Furthermore, to mitigate the influence of extreme outliers related to the COVID-19 pandemic, we include exogenous dummy variables equal to one during months with pandemic containment measures (i.e., during the period from February 2020 to May 2021 in Switzerland, see Table A.1 in the appendix) and zero otherwise. The coefficient β_h measures the response of π^*_j at time $t+h$ to the shock at time t.

We evaluate the response of inflation to the various shocks based on the recomposed inflation rate (Equation (5)) alongside four counterfactual inflation rates employed to isolate the effects of variations in the frequency and size of price changes (Equation (3), Equation (4), Equation (6) and Equation (7)). The sample covers the period from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution.[27] We focus exclusively on items consistently collected at a monthly frequency and further exclude energy items from the baseline dataset. Since prices are usually collected in the first two weeks of each month, we lead the cumulated inflation rates by one month to ensure that a shock in month t can only influence price-setting responses from month $t+1$ onward.

The sequence of β_h values is obtained by estimating the linear regression Equation (8) separately for each horizon h and interpreted as the impulse response function (IRF) of the dependent variable. Figure 8 plots the resulting IRFs. The rows represent the different shocks (oil supply news, safe haven, global demand, and monetary policy). The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and the counterfactual inflation rates calculated by assuming either constant size or constant frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_f$), and either constant sizes or constant frequencies of price increases

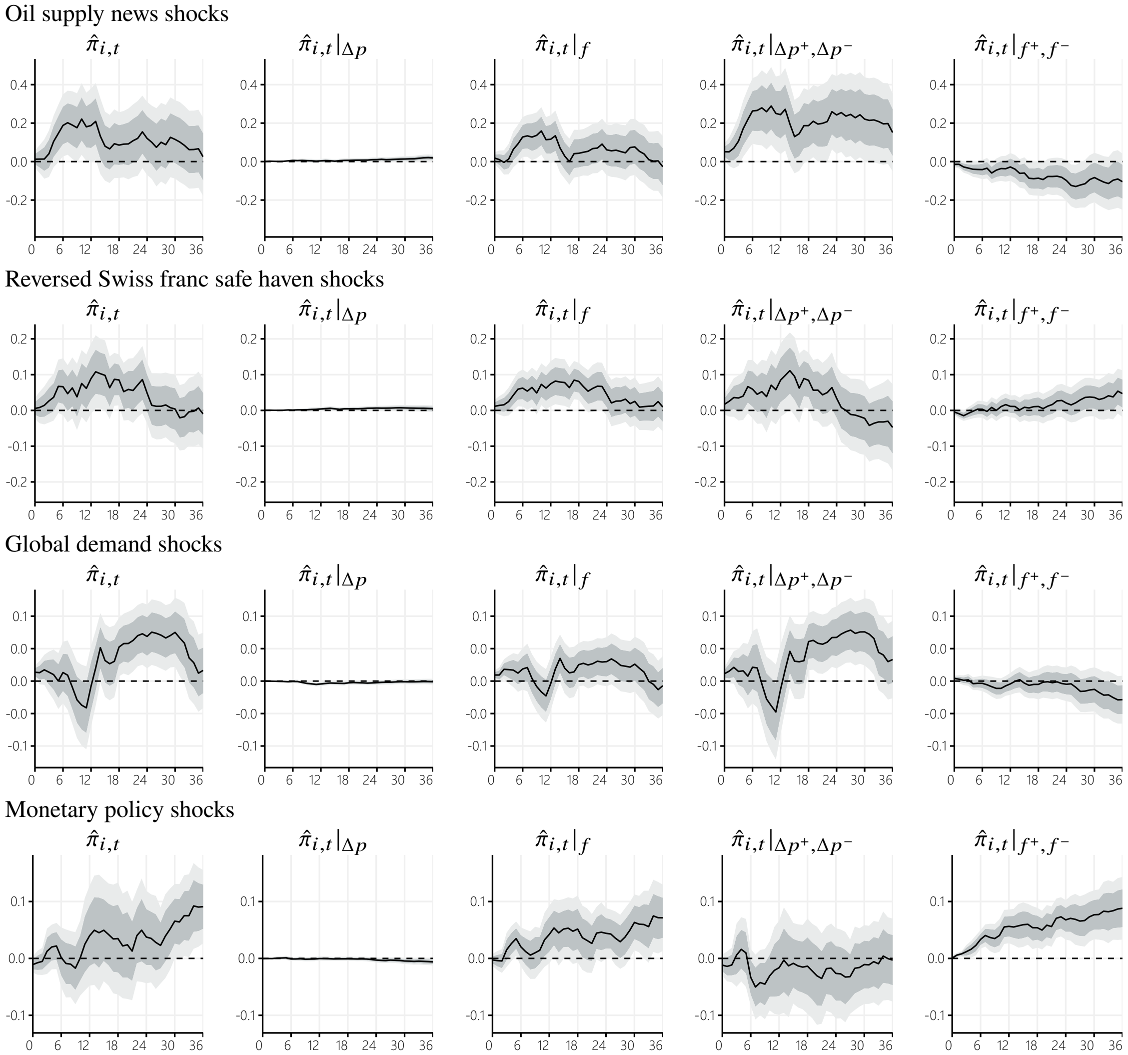
[25] Appendix E.1 provides more information on the shock variables used in the local projections estimations. Figure E.1 in the appendix shows the time series of the shocks over the sample period.

[26] We approximate industrial production in Switzerland using the monthly KOF barometer (Abberger et al., 2014).

[27] Appendix E.2 provides an analysis of the robustness of our baseline results to the treatment of temporary sales and product substitutions. The IRFs are quite similar when price changes due to temporary sales (Figure E.2), or product substitution (Figure E.3), or both (Figure E.4) are excluded.

and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). To make the results easier to interpret, we rescale the IRFs to produce a 10 percent increase in monthly Brent crude oil price changes (oil supply news shock), a 10 percent depreciation of the Swiss franc against the euro (reversed safe haven shock), a 10 percent increase in monthly changes in industrial production (global demand shock), and a 0.25 percentage point reduction in the Swiss Average Rate Overnight (SARON) for monetary policy shocks. Hence, we expect all shocks to have a positive effect on inflation.

Figure 8: Conditional responses of (recomposed and counterfactual) inflation rates to aggregate shocks from linear local projections



Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to aggregate shocks estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs to the different shocks: oil supply news, safe haven, global demand, and monetary policy. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

The IRFs in the first column of Figure 8 display the effects of the various shocks on the recomposed inflation rate. The results show positive price responses to all shocks. However, adjustments occur at varying speeds. Inflation responds most rapidly to oil supply news shocks. Swiss franc safe haven shocks and global demand shocks take more time to cumulate, and their effects on inflation peak later. Monetary policy shocks trigger the slowest response.[28]

Turning to the IRFs of shocks on the counterfactual inflation rates, the responses are not statistically different from zero for all shocks when the size of price changes is held constant (Figure 8, second column). By contrast, assuming a constant frequency (third column) yields IRFs similar to those for the recomposed inflation reported in the first column. These results indicate that firms adjust the size rather than the frequency of price changes in response to aggregate shocks. Figure 8 further reports IRFs associated with counterfactual inflation calculated by assuming constant sizes (fourth column) and constant frequencies (fifth column) of price increases and decreases. The results show that assuming constant sizes of price increases and decreases leads to IRFs closely mirroring the corresponding IRFs of recomposed inflation, underscoring the importance of frequency adjustments. Thus, aggregate shocks affect the price change distribution primarily by altering the shares of price increases and decreases rather than their magnitudes. Overall, the price-setting behavior reflected in the IRFs is consistent with the predictions of Calvo (1983).

6.2.2 Nonlinear local projections

The linear local projections framework employed so far analyzes the average inflation response to aggregate shocks, assuming homogeneity in the transmission of shocks over the sample period. However, the transmission of shocks may exhibit nonlinearities arising from time variation in the underlying price-setting behavior, as illustrated in Section 3.3.[29] Alvarez et al. (2016) propose a "sufficient statistic" for measuring the output response to a monetary policy shock. According to their framework, the cumulative output response is proportional to the ratio of the kurtosis of the distribution of non-zero price changes to the frequency of price adjustments. A high value of the sufficient statistic implies a strong output response to monetary policy shocks, reflecting either a high degree of nominal price rigidity (low frequency), stronger price selection (high kurtosis), or both. Conversely, a low value of the statistic suggests a muted output response, indicating either a low degree of nominal rigidity, weak price selection, or both.

Alvarez et al. (2016) derive their sufficient statistic based solely on steady-state price-setting moments. However, using monthly price-setting moments could provide valuable insights into the evolution of monetary non-neutrality over time. For the nonlinear local projections estimates, we compute sufficient statistics at the item level for each month:

[28] Appendix E.3 presents sectoral results on inflation responses to the various shocks. Oil supply news shocks drive price increases across all sectors, with the most pronounced and immediate effect on energy prices (Figure E.5). Swiss franc safe haven shocks primarily impact food prices and, to a lesser extent, NEIG (Figure E.6). Global demand shocks have a particularly strong effect on NEIG prices (Figure E.7). Monetary policy shocks also influence food and NEIG prices, while their effect on services remains limited over the estimation horizon (Figure E.8).

[29] Several empirical studies document that the frequency of price changes increases with inflation both before (e.g., Gagnon, 2009; Nakamura et al., 2018; Alvarez et al., 2019; Karadi and Reiff, 2019) and during the pandemic (e.g., Montag and Villar, 2022; Blanco et al., 2024). Cavallo (2018a) documents an increase in the frequency of price changes driven by an increase in online competition in data of US multi-channel retailers between 2008 and 2017. Cavallo et al. (2024) document changes in price-setting behavior depending on the size of the aggregate shock.

$$z_{i,t} = \frac{\text{Kur}(\Delta p_{i,t})}{f_{i,t}}, \tag{9}$$

where $\text{Kur}(\Delta p_{i,t})$ and $f_{i,t}$ are the kurtosis of the price change distribution and the frequency of price changes for item i in month t.

To explore potential state dependence in the transmission of aggregate shocks to inflation, we extend the linear model in Equation (8) to a nonlinear local projections framework, which conditions the inflation response $\pi^*_{i,t-1,t+h}$ for item i between periods $t-1$ and $t+h$ on the state variable $z_{i,t}$:

$$\begin{aligned} \pi^*_{i,t-1,t+h} = F(z_{t-1})&\left(\alpha^L_{i,h} + \alpha^L_{m,h}\beta^L_h S_t + \gamma^L_h X_t\right) + \\ &(1 - F(z_{t-1}))\left(\alpha^H_{i,h} + \alpha^H_{m,h}\beta^H_h S_t + \gamma^H_h X_t\right) + \varepsilon_{i,t_h}, \end{aligned} \tag{10}$$

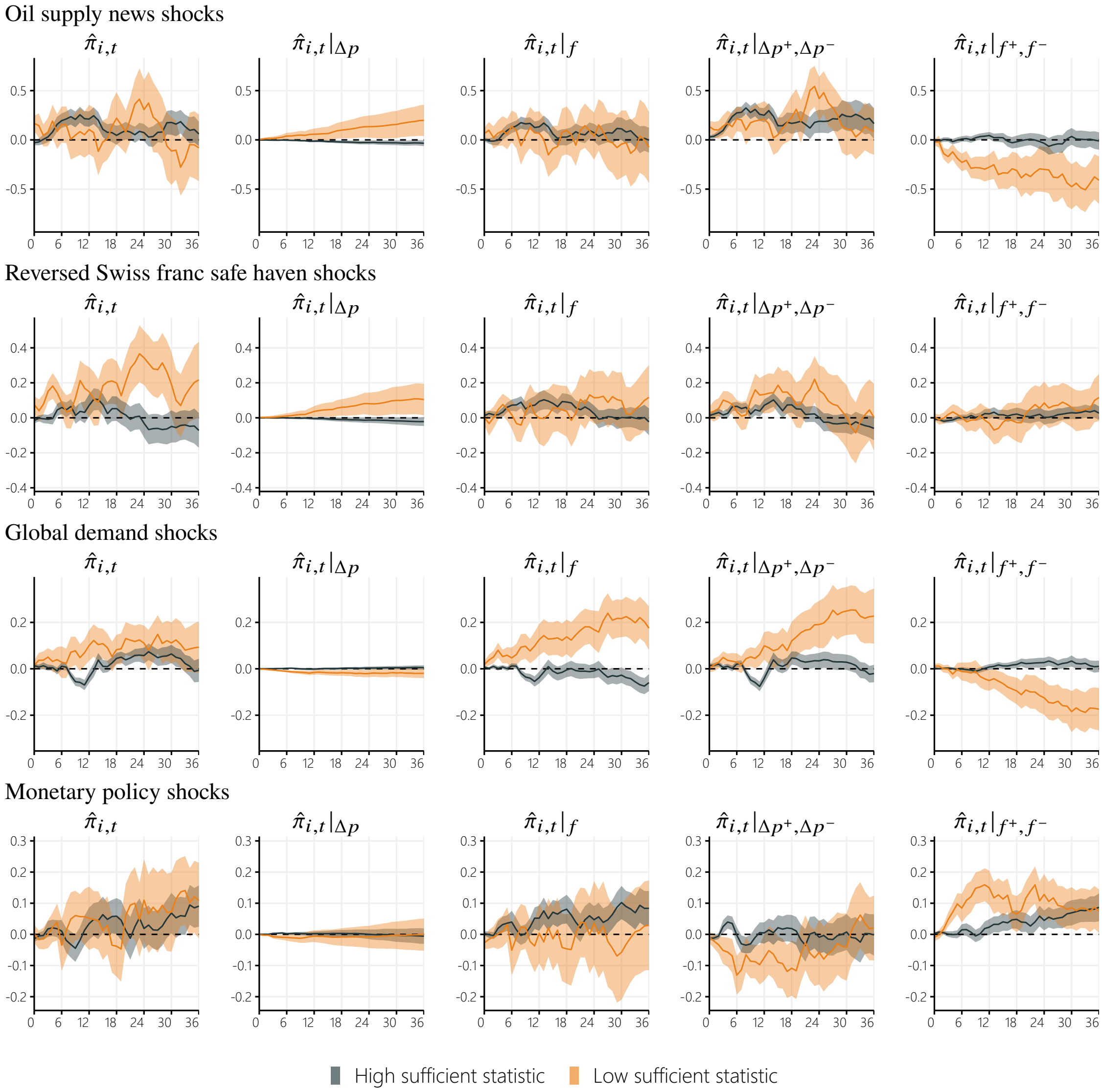
To model the transitions between states, we follow Granger and Teräsvirta (1993) and use the logistic function, which casts the state variable into the unit interval and smooths[30] the transitions between states:

$$F(z_{i,t}) = \frac{e^{-\gamma(z_{i,t}-\mu_{i,z})/\sigma_{i,z}}}{1 + e^{-\gamma(z_{i,t}-\mu_{i,z})/\sigma_{i,z}}} \in [0,1], \quad \gamma > 0. \tag{11}$$

Since the logistic function $F(z_{i,t})$ is decreasing in $z_{i,t}$, values of $F(z_{i,t})$ close to zero indicate states with a high degree of non-neutrality. Figure E.9 in the appendix displays the distribution of the smooth transition functions, $F(z_{i,t})$, aggregated across items using CPI expenditure weights. The distribution of smooth transition functions is relatively broad and centered around the mean of 0.5, suggesting that items with both low and high degrees of non-neutrality are identified over the sample period. It narrows and rises after 2015 and, even more so, in 2022, suggesting that there are more items with low degrees of non-neutrality in these periods.

[30] The transition function standardizes the state variable $z_{i,t}$ by subtracting its mean $\mu_{i,z}$ and dividing it by its variance $\sigma_{i,z}$. This splits the estimates roughly equally between the two states over the estimation period. The parameter γ determines the intensity of the switching between states as $z_{i,t}$ changes. Higher values of γ mean that $F(z_{i,t})$ spends more time near the bounds of the unit interval, bringing the model closer to a discrete regime switching setup. We set $\gamma = 3$, which gives an intermediate level of regime switching intensity.

Figure 9: Conditional responses of (recomposed and counterfactual) inflation rates to aggregate shocks from nonlinear local projections



Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to aggregate shocks estimated using panel nonlinear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (10). The state variables are the item-level sufficient statistics calculated as in Equation (9). The rows represent the IRFs to the different shocks: oil supply news, safe haven, global demand, and monetary policy. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The areas are the 68 percent confidence bands.

Figure 9 shows the IRFs from the nonlinear local projections estimates using the item-level sufficient statistics as the state variables. The rows represent the different shocks (oil supply news, safe haven, global demand, and monetary policy). The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and the counterfactual inflation rates ($\hat{\pi}_{i,t}|_{\Delta p}$, $\hat{\pi}_{i,t}|_{f}$, $\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The IRFs are rescaled in the same manner as in Figure 8.

The IRFs for recomposed inflation, shown in the first column of Figure 9, reveal distinct price responses to aggregate shocks across regimes. When the sufficient statistic is high, the coefficients associated with the response of recomposed inflation are small and often not significantly different from zero. By contrast, during periods of low sufficient statistics, price responses are not only significantly positive but also larger and quicker.

The sufficient statistic proves effective in distinguishing between regimes of different shock transmission. Periods characterized by low sufficient statistics feature either more frequent price adjustments, a low kurtosis of the distribution of price changes, or both, resulting in increased flexibility of the aggregate price level. During such periods, the pass-through of any shock to consumer prices is faster than during periods of higher sufficient statistics, leading to quicker price responses.

To further isolate the influence of the underlying price-setting moments on recomposed inflation responses, we examine IRFs derived from counterfactual inflation rates assuming either constant size (second column) or constant frequency of price changes (third column). The results highlight a notable contrast. For all shocks except for the global demand shocks, the IRFs under the constant frequency assumption are not significantly different from zero across regimes and horizons. By contrast, IRFs under the constant size assumption exhibit statistical significance during periods of low sufficient statistics but not during periods of high sufficient statistics.

This finding differs from the results of the linear local projections, where firms appeared not to adjust the frequency of their price changes in response to aggregate shocks. The nonlinear local projections framework provided evidence of state-dependent pricing, where the greater flexibility of the aggregate price level—driven by either more frequent price adjustments, stronger price selection, or both—enables firms to respond to shocks not only through the size but also through the frequency of price changes. This behavior aligns with predictions from state-dependent models of price rigidity and is consistent with empirical findings documenting an increase in the frequency of price changes in response to large shocks (Cavallo et al., 2024).

7 Conclusion

Empirical findings on price-setting behavior allow us to better understand price rigidity at the product level. Estimates of price-setting characteristics are often relevant for calibrating macroeconomic models with nominal price stickiness. In this paper, we have reconsidered price-setting behavior in Switzerland, focusing on changes in price-setting characteristics over time. The data comprise the microdata underlying the CPI from January 2008 to December 2022.

The main findings can be summarized as follows. First, the frequency of price changes has increased in the decade leading up to the COVID-19 pandemic. This increase was mainly driven by the rise of e-commerce. Because prices on online platforms are adjusted considerably more frequently than prices at stationary retailers, the increasing share of online prices in the CPI had a direct impact on the total frequency of price changes. Second, at the onset of the pandemic, price-setting characteristics changed relatively little, on average. However, the price-setting responses varied widely across sectors, reflecting the fact that the pandemic hit the economy unevenly. Temporary sales, in particular, responded countercyclically to the respective demand conditions across sectors. Third, the increase in the frequency of price changes accelerated with the rise in inflation in the later stage of the pandemic. However, unlike in the pre-pandemic period, this increase was broad-based rather than confined to a relatively small group of goods and services. Fourth, time variation in the frequency of price changes contributes little to variations in inflation. However, the frequency of price increases and the frequency of price decreases, considered separately, contribute substantially to variations in inflation. Their contribution even exceeds that of the size of price increases and decreases.

Finally, we use local projections to assess how the extensive and intensive margins of price adjustment contribute to the response of inflation following various types of aggregate shocks. Results from linear local projections suggest that firms adjust the size rather than the frequency of price changes in response to such shocks. This result is consistent with predictions from time-dependent models of price rigidity. However, nonlinear local projections provide a slightly different picture. Using monthly series of an item-level version of the sufficient statistic proposed by Alvarez et al. (2016) to distinguish between periods of high and low responsiveness of output, we find evidence that in periods of low output responsiveness—indicative of either high price flexibility, strong price selection, or both—firms respond to aggregate shocks not only through the size of price changes but also by increasing their price adjustment frequency. This pattern aligns with predictions from state-dependent models of price rigidity.

References

Abberger, Klaus, Michael Graff, Boriss Siliverstovs, and Jan-Egbert Sturm (2014) "The KOF economic barometer, version 2014: A composite leading indicator for the Swiss business cycle," KOF Working Paper 353, ETH Zurich.

Alvarez, Fernando, Martin Beraja, Martin Gonzalez-Rozada, and Pablo Andrés Neumeyer (2019) "From hyperinflation to stable prices: Argentina's evidence on menu cost models," *The Quarterly Journal of Economics*, Vol. 134, pp. 451–505.

Alvarez, Fernando, Herve Le Bihan, and Francesco Lippi (2016) "The real effects of monetary shocks in sticky price models: A sufficient statistic approach," *American Economic Review*, Vol. 106, pp. 2817–51.

Alvarez, Santiago E and Sarah M Lein (2020) "Tracking inflation on a daily basis," *Swiss Journal of Economics and Statistics*, Vol. 156, pp. 1–13.

Anderson, Eric, Benjamin A Malin, Emi Nakamura, Duncan Simester, and Jón Steinsson (2017) "Informational rigidities and the stickiness of temporary sales," *Journal of Monetary Economics*, Vol. 90, pp. 64–83.

Baker, Scott R, Robert A Farrokhnia, Steffen Meyer, Michaela Pagel, and Constantine Yannelis (2020) "How does household spending respond to an epidemic? Consumption during the 2020 COVID-19 pandemic," *The Review of Asset Pricing Studies*, Vol. 10, pp. 834–862.

Balleer, Almut, Sebastian Link, Manuel Menkhoff, and Peter Zorn (2024) "Demand or supply? Price adjustment during the Covid-19 pandemic," *International Journal of Central Banking*, Vol. 20, pp. 93–158.

Balleer, Almut and Peter Zorn (2019) "Monetary policy, price setting, and credit constraints," Working Paper 7978, CESifo, Munich Society for the Promotion of Economic Research.

Baumeister, Christiane and James D Hamilton (2019) "Structural interpretation of vector autoregressions with incomplete identification: Revisiting the role of oil supply and demand shocks," *American Economic Review*, Vol. 109, pp. 1873–1910.

Berardi, Nicoletta, Erwan Gautier, and Herve Le Bihan (2015) "More facts about prices: France before and during the Great Recession," *Journal of Money, Credit and Banking*, Vol. 47, pp. 1465–1502.

Bils, Mark and Peter J Klenow (2004) "Some evidence on the importance of sticky prices," *Journal of Political Economy*, Vol. 112, pp. 947–985.

Blanco, Andres, Corina Boar, Callum J Jones, and Virgiliu Midrigan (2024) "Non-linear inflation dynamics in menu cost economies," Working Paper No. w32094, National Bureau of Economic Research.

Boneva, Lena (2024) "A safe haven indicator," Mimeo, Swiss National Bank.

Brown, Martin, Matthias R Fengler, Jonas Huwyler, Winfried Koeniger, Rafael Lalive, and Robert Rohrkemper (2023) "Monitoring consumption Switzerland: Data, background, and use cases," *Swiss Journal of Economics and Statistics*, Vol. 159, p. 4.

Bu, Chunya, John Rogers, and Wenbin Wu (2021) "A unified measure of Fed monetary policy shocks," *Journal of Monetary Economics*, Vol. 118, pp. 331–349.

Calvo, Guillermo (1983) "Staggered prices in a utility-maximizing framework," *Journal of Monetary Economics*, Vol. 12, pp. 383–398.

Carvalho, Vasco M, Juan R Garcia, Stephen Hansen, Álvaro Ortiz, Tomasa Rodrigo, José V Rodríguez Mora, and Pep Ruiz (2021) "Tracking the COVID-19 crisis with high-resolution transaction data," *Royal Society Open Science*, Vol. 8, p. 210218.

Cavallo, Alberto (2018a) "More Amazon effects: Online competition and pricing behaviors," Working Paper No. w25138, National Bureau of Economic Research.

——— (2018b) "Scraped data and sticky prices," *Review of Economics and Statistics*, Vol. 100, pp. 105–119.

Cavallo, Alberto and Oleksiy Kryvtsov (2023) "What can stockouts tell us about inflation? Evidence from online micro data," *Journal of International Economics*, Vol. 146, p. 103769.

Cavallo, Alberto, Francesco Lippi, and Ken Miyahara (2024) "Large shocks travel fast," *American Economic Review: Insights*, Vol. 6, pp. 558–574.

Ciminelli, Gabriele, John Rogers, and Wenbin Wu (2022) "The effects of US monetary policy on international mutual fund investment," *Journal of International Money and Finance*, Vol. 127, p. 102676.

Dedola, Luca, Erwan Gautier, Chiara Osbat, and Sergio Santoro (forthcoming) "Price stickiness in the euro area," in Guido Ascari and Riccardo Trezzi eds. *Research Handbook of Inflation*: Edward Elgar Publishing.

Dedola, Luca, Mark Strøm Kristoffersen, and Gabriel Züllig (2021) "The extensive and intensive margin of price adjustment to cost shocks: Evidence from Danish multiproduct firms," Mimeo, European Central Bank.

Dhyne, Emmanuel, Luis J Alvarez, Hervé Le Bihan, Giovanni Veronese, Daniel Dias, Johannes Hoffmann, Nicole Jonker, Patrick Lunnemann, Fabio Rumler, and Jouko Vilmunen (2006) "Price changes in the euro area and the United States: Some facts from individual consumer price data," *Journal of Economic Perspectives*, Vol. 20, pp. 171–192.

Eichenbaum, Martin, Nir Jaimovich, and Sergio Rebelo (2011) "Reference prices, costs, and nominal rigidities," *American Economic Review*, Vol. 101, pp. 234–62.

Eichenbaum, Martin, Nir Jaimovich, Sergio Rebelo, and Josephine Smith (2014) "How frequent are small price changes?" *American Economic Journal: Macroeconomics*, Vol. 6, pp. 137–55.

Föllmi, Reto, Rudolf Minsch, and Fabian Schnell (2016) "What determines price changes and the distribution of prices? Evidence from the Swiss CPI," Discussion Paper 2016-10, University of St. Gallen.

FSO (2016) *Swiss Consumer Price Index (December 2015=100). Methodological foundations*, No. 855-1500, Neuchâtel: Swiss Federal Statistical Office (FSO).

——— (2021) "The 2020 revisions of price statistics and introduction of an official property price index," Press conference, 26 November 2020.

——— (2022) *Swiss Consumer Price Index (December 2020=100). Methodological foundations*, No. 855-2000, Neuchâtel: Swiss Federal Statistical Office (FSO).

Gagnon, Etienne (2009) "Price setting under low and high inflation: Evidence from Mexico," *The Quarterly Journal of Economics*, Vol. 124, pp. 1221–63.

Gautier, Erwan, Cristina Conflitti, Riemer P Faber, Brian Fabo, Ludmila Fadejeva, Valentin Jouvanceau, Jan-Oliver Menz, Teresa Messner, Pavlos Petroulas, Pau Roldan-Blanco et al. (2024) "New facts on consumer price rigidity in the euro area," *American Economic Journal: Macroeconomics*, Vol. 16, pp. 386–431.

Gertler, Mark and Peter Karadi (2015) "Monetary policy surprises, credit costs, and economic activity," *American Economic Journal: Macroeconomics*, Vol. 7, pp. 44–76.

Golosov, Mikhail and Robert E Lucas (2007) "Menu costs and Phillips curves," *Journal of Political Economy*, Vol. 115, pp. 171–199.

Gorodnichenko, Yuriy, Sheremirov Slavik, and Oleksandr Talavera (2018) "The response of internet retail prices to aggregate shocks: A high frequency approach," *Economic Letters*, Vol. 164, pp. 124—127.

Gorodnichenko, Yuriy and Oleksandr Talavera (2017) "Price setting in online markets: Basic facts, international comparisons, and cross-border integration," *American Economic Review*, Vol. 107, pp. 249—282.

Granger, Clive WJ and Timo Teräsvirta (1993) *Modelling nonlinear economic relationships*: Oxford University Press.

HANDELSVERBAND.swiss (2022) "Facts on the Swiss online shipping trade," https://handelsverband.swiss/facts/facts-zur-schweiz/ [Accessed: 2025 02 28].

Henkel, Lukas, Elisabeth Wieland, Aneta B lażejowska, Cristina Conflitti, Brian Fabo, Ludmila Fadejeva, Jana Jonckheere, Peter Karadi, Pawe l Macias, Jan-Oliver Menz, Pascal Seiler, and Karol Szafranek (2023) "Price setting during the coronavirus (COVID-19) pandemic," Occasional Paper 324, European Central Bank.

Jordà, Òscar (2005) "Estimation and inference of impulse responses by local projections," *American Economic Review*, Vol. 95, pp. 161–182.

Känzig, Diego R (2021) "The macroeconomic effects of oil supply news: Evidence from OPEC announcements," *American Economic Review*, Vol. 111, pp. 1092–1125.

Karadi, Peter, Juergen Amann, Javier Sánchez Bachiller, Pascal Seiler, and Jesse Wursten (2023) "Price setting on the two sides of the Atlantic - Evidence from supermarket scanner data," *Journal of Monetary Economics*, Vol. 140, pp. 1–17.

Karadi, Peter and Adam Reiff (2019) "Menu costs, aggregate fluctuations, and large shocks," *American Economic Journal: Macroeconomics*, Vol. 11, pp. 111–46.

Kaufmann, Daniel (2009) "Price-setting behaviour in Switzerland: Evidence from CPI micro data," *Swiss Journal of Economics and Statistics*, Vol. 145, pp. 293–349.

Kehoe, Patrick and Virgiliu Midrigan (2015) "Prices are sticky after all," *Journal of Monetary Economics*, Vol. 75, pp. 35–53.

Klenow, Peter J and Oleksiy Kryvtsov (2008) "State-dependent or time-dependent pricing: Does it matter for recent US inflation?" *The Quarterly Journal of Economics*, Vol. 123, pp. 863–904.

Klenow, Peter J and Benjamin A Malin (2010) "Microeconomic evidence on price-setting," in *Handbook of Monetary Economics*, Vol. 3: Elsevier, pp. 231–284.

Klenow, Peter J and Jonathan L Willis (2007) "Sticky information and sticky prices," *Journal of Monetary Economics*, Vol. 54, pp. 79–99.

Kryvtsov, Oleksiy and Nicolas Vincent (2021) "The cyclicality of sales and aggregate price flexibility," *The Review of Economic Studies*, Vol. 88, pp. 334–377.

Montag, Hugh and Daniel Villar (2022) "Price-setting during the Covid era," Working Paper 547, U.S. Bureau of Labor Statistics.

Nakamura, Emi and Jón Steinsson (2008) "Five facts about prices: A reevaluation of menu cost models," *The Quarterly Journal of Economics*, Vol. 123, pp. 1415–1464.

——— (2010) "More facts about prices. Supplement to: "Five facts about prices: A reevaluation of menu cost models"," https://eml.berkeley.edu/~enakamura/papers/fivefactssupplement.pdf [Accessed: 2025 02 28].

——— (2013) "Price rigidity: Microeconomic evidence and macroeconomic implications," *Annual Review of Economics*, Vol. 5, pp. 133–163.

Nakamura, Emi, Jón Steinsson, Patrick Sun, and Daniel Villar (2018) "The elusive costs of inflation: Price dispersion during the US Great Inflation," *The Quarterly Journal of Economics*, Vol. 133, pp. 1933–1980.

Nitschka, Thomas and Alex Oktay (2023) "What the term structure of interest rates tells us about monetary policy shocks," Mimeo, Swiss National Bank.

Rudolf, Barbara and Pascal Seiler (2022) "Price setting before and during the pandemic: Evidence from Swiss consumer prices," Working Paper 2748, European Central Bank.

Vavra, Joseph (2014) "Inflation dynamics and time-varying volatility: New evidence and an Ss interpretation," *The Quarterly Journal of Economics*, Vol. 129, pp. 215–258.

Woodford, Michael (2009) "Information-constrained state-dependent pricing," *Journal of Monetary Economics*, Vol. 56, pp. S100–S124.

Wulfsberg, Fredrik (2016) "Inflation and price adjustments: Micro evidence from Norwegian consumer prices 1975-2004," *American Economic Journal: Macroeconomics*, Vol. 8, pp. 175–94.

Table 1: Summary of the data sample

	Jan 2008 – Dec 2022	CPI weight (%)
Price quotes		
Total	8,581,029	54.1
Average per month	47,672	
Price series	177,377	
Temporary sales	427,058	
Substitutions	290,029	
Outlets	3,480	
Expenditure items	266	
Varieties	1,269	
Sample composition (%)		
Food	33.0	13.2
NEIG	46.1	17.7
Energy	2.4	3.7
Services	18.5	19.6

Notes: Summary statistics of the data sample covering the period from January 2008 to December 2022 after applying our sampling decisions. The CPI weights refer to the average CPI expenditure weight over the sample period from January 2008 to December 2022.

Table 2: Frequency and size of price adjustments

	Frequency of price adjustments				Size of price adjustments			
	Changes	Increases	Decreases	Share of Increases	Average Changes	Absolute Changes	Increases	Decreases
	f	f^+	f^-		Δp	$\|\Delta p\|$	Δp^+	Δp^-
Including sales, including substitutions								
Mean	26.2	14.0	12.2	55.8	0.3	11.1	10.4	-11.6
Median	15.8	6.5	5.2		0.6	7.9	7.0	-8.3
Std. dev.	28.9	20.1	18.8		11.5	10.7	10.8	11.4
Excluding sales, including substitutions								
Mean	24.2	13.1	11.2	56.8	0.5	8.3	7.9	-8.7
Median	11.9	5.2	3.6		0.6	6.4	5.8	-6.4
Std. dev.	29.1	20.1	18.8		7.9	7.2	7.5	8.4
Including sales, excluding substitutions								
Mean	24.3	12.8	11.5	55.8	-0.1	10.8	9.8	-11.3
Median	13.6	5.4	4.3		0.5	7.3	6.4	-7.7
Std. dev.	28.4	19.6	18.6		11.9	10.9	10.6	11.6
Excluding sales, excluding substitutions								
Mean	22.5	12.1	10.4	57.4	0.6	7.4	7.0	-7.7
Median	9.6	4.1	2.6		0.7	5.6	5.1	-5.6
Std. dev.	28.8	19.7	18.5		7.4	6.7	6.8	7.6

Notes: The sample ranges from January 2008 to December 2022. The frequency of price "changes," "increases," and "decreases" refer to the weighted averages of the share of price changes, increases, and decreases, respectively. "Share of increases" refers to the share of price increases in all price changes. The size of "average" price changes, "absolute" price changes, price "increases," and "decreases" refer to the weighted averages of the average size of price changes, the absolute size of price changes, the size of price increases and the size of price decreases, respectively. All moments are calculated for each variety and aggregated using a weighted mean (median or standard deviation) across varieties using CPI expenditure weights. All moments are reported in percent per month.

Table 3: Cross-correlations between inflation and counterfactual inflation rates

	$\hat{\pi}_t\vert_{\Delta p}$	$\hat{\pi}_t\vert_{f}$	$\hat{\pi}_t\vert_{\Delta p^+,\Delta p^-}$	$\hat{\pi}_t\vert_{f^+,f^-}$
$\hat{\pi}_{i,t}$	0.115	0.844	0.777	0.592
Food	0.083	0.879	0.733	0.617
NEIG	0.020	0.723	0.704	0.655
Energy	0.026	0.983	0.859	0.685
Services	0.273	0.804	0.717	0.500

Notes: The table shows cross-correlations between inflation, as in Equation (5), and counterfactual inflation rates as in Equation (3), Equation (4), Equation (6), and Equation (7). Statistics are calculated by expenditure item i and month t and aggregated using CPI expenditure weights. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution.

Appendix

Price Setting Before and During the Pandemic: Evidence from Swiss Consumer Prices

Barbara Rudolf
Swiss National Bank

Pascal Seiler
ETH Zurich

In this appendix, we present additional figures, tables and analyses that are not featured in the main body of the paper. The appendices refer to the corresponding sections in the main text.

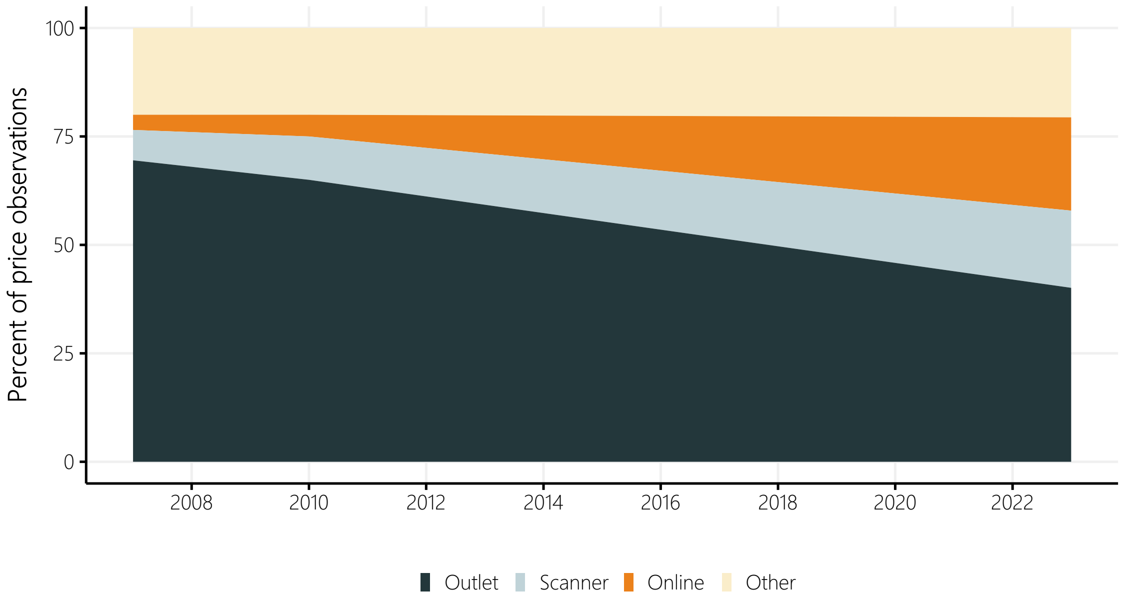
A Data

This appendix refers to Section 2 in the main body of the paper and presents additional figures, tables, and analyses that are not featured in the main text.

A.1 Price quotes

Traditionally, the FSO has collected most prices directly in the outlets. This practice involves price collectors visiting the stores, finding the products to be collected, and recording their prices. The share of price observations recorded directly in stores has declined substantially over time. Figure A.1 shows the approximate shares of different price collection methods in the total of all price observations.

Figure A.1: Price collection methods



Notes: Development of price collection methods from 2008 to 2022. The figure shows the percentage of prices collected by each collection method. "Outlet" refers to the share of price quotes collected in stores. "Scanner" refers to prices collected as part of scanner data. "Online" refers to prices collected on the internet. "Other" includes prices collected by other means, such as paper forms, e-mail, telephone, online surveys, or secondary data sources. Sources: FSO (2021).

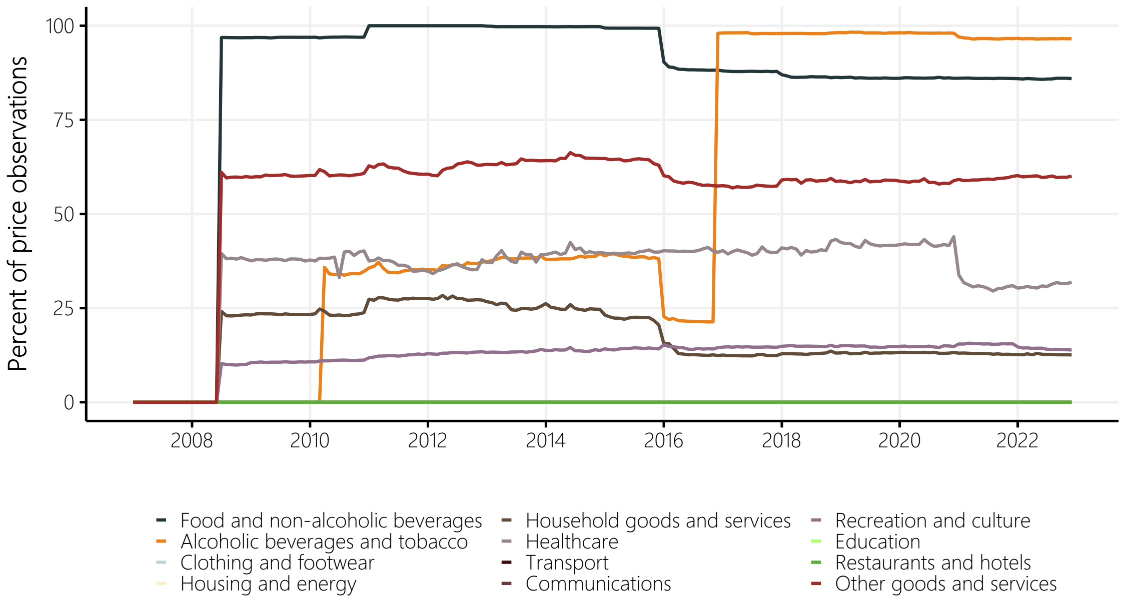
The FSO introduced scanner data in July 2008 and broadened the range of product categories for which prices are collected as scanner data in April 2010, April 2012, and December 2016. Figure A.2 shows the percentage of price quotes collected as scanner data for each main group in our sample from January 2008 to December 2022.

Today, the FSO collects most prices every month. The frequency of price collection changed significantly in January 2008, when the FSO started collecting most quarterly collected prices every month, as shown in Figure A.3.

A.2 Product substitutions and price imputations

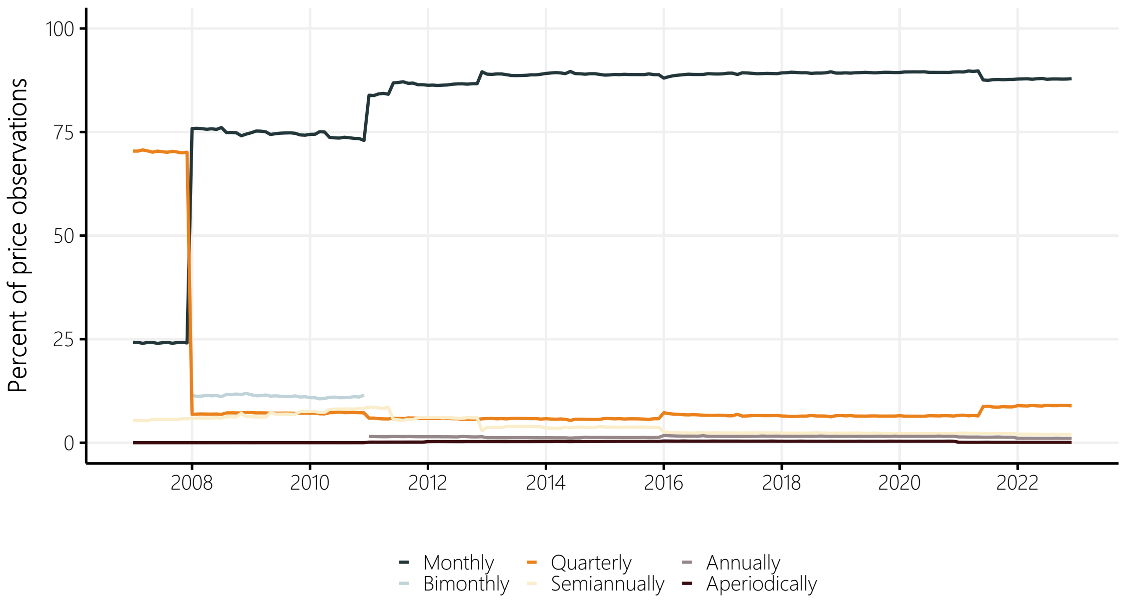
Figure A.4 shows the percentage of substituted products in the monthly collected prices of our sample.

Figure A.2: Scanner collection



Notes: Percentage of price quotes collected as scanner data from January 2008 to December 2022 for each main group.

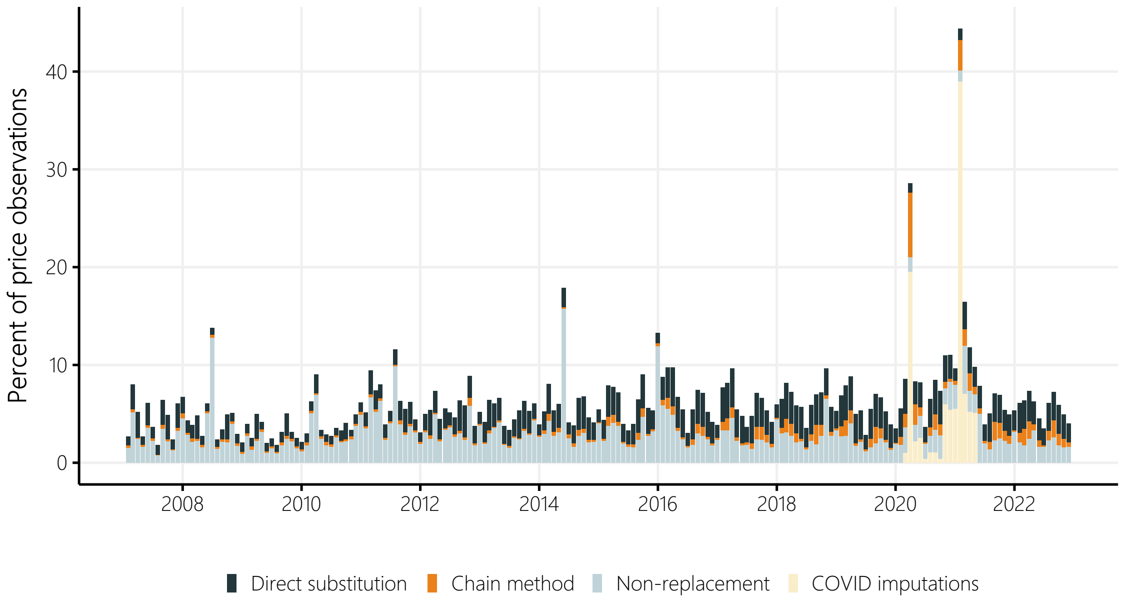
Figure A.3: Price collection frequency



Notes: Development of price collection frequency from 2008 to 2022. The figure shows the percentage of prices collected at each frequency.

The COVID-19 pandemic and the measures taken to contain it affected price surveys for the CPI in 2020 and 2021. The FSO could field only a partial price collection in many areas. Therefore, it had to impute many prices. Table A.1 lists the expenditure items whose prices were (fully or partially) imputed each month during the COVID-19 pandemic.

Figure A.4: Product substitutions and COVID imputations



Notes: Development of product substitutions from 2008 to 2022. The figure shows the percentage of the most common types of product substitution in our sample. "Direct substitution" is used when the old and new products share the same features or are very similar. The new product replaces the previous one, and any price difference is considered fully. The "chain method" applies to products that may have changed but whose primary function is the same. Any price difference between the old and new product is split into a difference in quality and price, but only the price difference is included in calculating the CPI. "Non-replacement" occurs if no other substitution method is applicable. The price spell of the old product is discontinued, and a new price spell is started. No price comparison is made. "COVID imputations" are price imputations during the COVID-19 pandemic.

Table A.1: COVID imputations

Month	Expenditure items	CPI weight
March 2020	Air transport; International package holidays	2.70
April 2020	Jackets for men; Men's suits; Men's trousers; Men's shirts; Men's knitwear; Men's underwear; Women's coats and jackets; Women's skirts and dresses; Women's trousers; Women's blouses; Women's jumpers; Women's underwear; Children's jackets; Children's trousers and skirts; Children's knitwear; Babies' clothing; Children's underwear; Summer/year-round sportswear; Other clothing accessories; Men's footwear; Women's footwear; Children's footwear; Air transport; International package holidays; Meals taken in restaurants and cafés; Wine; Beer; Spirits, other alcoholic drinks; Coffee and tea; Mineral water and soft drinks; Self-service restaurants; Hotels	26.56
May 2020	Air transport; International package holidays; Hotels	4.05
June 2020	Air transport; International package holidays; Hotels	4.05
July 2020	Air transport	0.72
August 2020	Air transport; Sporting events; Admission to sport facilities	0.76
September 2020	Air transport; Sporting events; Admission to sport facilities	0.76
October 2020	Air transport	0.72
November 2020	Air transport; International package holidays; Meals taken in restaurants and cafés; Wine; Beer; Spirits, other alcoholic drinks; Coffee and tea; Mineral water and soft drinks; Self-service restaurants; Fast food meals; Men's and children's hairdressers; Women's hairdressers	18.94
December 2020	Air transport; International package holidays; Meals taken in restaurants and cafés; Wine; Beer; Spirits, other alcoholic drinks; Coffee and tea; Mineral water and soft drinks; Self-service restaurants; Fast food meals	18.38
January 2021	Air transport; International package holidays; Meals taken in restaurants and cafés; Wine; Beer; Spirits, other alcoholic drinks; Coffee and tea; Mineral water and soft drinks; Self-service restaurants; Fast food meals	12.74
February 2021	Air transport; International package holidays; Meals taken in restaurants and cafés; Wine; Beer; Spirits, other alcoholic drinks; Coffee and tea; Mineral water and soft	12.74

B Evidence on the frequency and size of price changes

This appendix refers to Section 3 in the main body of the paper and presents additional figures, tables, and analyses that are not featured in the main text.

B.1 Alternative sale filters

In the main text, we rely on the sales flags provided by the FSO to identify temporary sales. In this appendix, we assess the robustness of our sale-filtered results by employing two alternative sale filters to identify and remove temporary sales from our data. For one, we employ a symmetric V-shaped sale filter proposed by Nakamura and Steinsson (2008), which aims at removing price patterns in which the price returns to the same price within 1 or 3 months. If the price does not return to the original price within the chosen window, we consider the price change a regular price change. In addition, we create monthly reference prices as 3-month running modal prices, which we iteratively update to align the reference-price change with the actual price change as in Kehoe and Midrigan (2015).

Table B.1 and Table B.2 present the frequency and size of price adjustments, respectively, for the two versions of the symmetric V-shaped sale filter and the running mode filter.

Table B.1: Frequency of price adjustments, alternative sale filters

	Frequency of price adjustments			
	Changes f	Increases f^+	Decreases f^-	Share Increases
V-shaped filter (1-month window)				
Mean	24.0	13.0	11.1	56.5
Median	12.8	5.4	4.0	
Std. dev.	28.3	19.7	18.4	
V-shaped filter (3-month window)				
Mean	19.5	11.0	8.6	58.6
Median	8.8	4.1	2.5	
Std. dev.	25.5	17.9	15.7	
Running mode filter (3-month window)				
Mean	22.7	12.1	10.6	55.7
Median	11.1	4.7	3.6	
Std. dev.	28.2	19.2	17.9	

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to product substitution. The V-shaped filter removes symmetric V-shaped price changes, following the algorithm of Nakamura and Steinsson (2008). We consider 1-month and 3-month windows. The running mode filter removes price changes following the algorithm of Kehoe and Midrigan (2015). The frequencies of price "changes," "increases," and "decreases" refer to the weighted averages of the shares of price changes, increases, and decreases, respectively. The mean frequency of price changes is calculated by first computing the frequency of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Median statistics and statistics of standard deviations are calculated analogously. "Share of increases" refers to the share of price increases in all price changes. Frequencies of price adjustments are reported in percent per month.

Table B.2: Size of price adjustments, alternative sale filters

	Size of price adjustments			
	Average Changes Δp	Absolute Changes $\lvert\Delta p\rvert$	Increases Δp^+	Decreases Δp^-
V-shaped filter (1-month window)				
Mean	0.2	10.7	9.9	-11.1
Median	0.7	7.4	6.5	-7.7
Std. dev.	11.6	10.6	10.6	11.3
V-shaped filter (3-month window)				
Mean	0.3	10.4	9.6	-11.1
Median	0.7	7.3	6.4	-7.7
Std. dev.	11.4	10.3	10.4	11.2
Running mode filter (3-month window)				
Mean	0.4	8.1	7.7	-8.3
Median	0.5	5.7	5.3	-5.7
Std. dev.	8.2	7.9	8.0	8.3

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to product substitution. The V-shaped filter removes symmetric V-shaped price changes, following the algorithm of Nakamura and Steinsson (2008). We consider 1-month and 3-month windows. The running mode filter removes price changes following the algorithm of Kehoe and Midrigan (2015). The sizes of "absolute" price changes, price "increases," and "decreases" refer to the weighted averages of the absolute size of price changes, size of price increases, and absolute size of price decreases, respectively. The mean size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Median statistics and statistics of standard deviations are calculated analogously. Price changes are reported in percent per month.

B.2 Mismeasurement issues in CPI microdata

As discussed in Section 2.6, we discard the following prices from our dataset to obtain our baseline sample: price imputations (as far as they can be identified), prices derived from auxiliary indices, and prices of administered or semi-administered prices. In addition, we exclude price changes greater than the 99th percentile of absolute log price changes and smaller than the 1st percentile for every variety.

Eichenbaum et al. (2014) raise various concerns with respect to mismeasurement in the context of CPI microdata. In what follows, we examine to what extent these concerns apply to our data. Eichenbaum et al. (2014) identify 27 problematic items in the US CPI. By problematic, they mean that spurious small price changes arise because of the method used to measure prices. Problematic prices are non-transactional prices that are computed as auxiliary indices or pertain to bundles of goods. We are able to match 20 of the 27 items with their counterparts in our Swiss dataset. Of these 20 problematic items, 11 are excluded by our sampling decisions summarized above. The 9 items that remain in the dataset are arguably all single-good transaction prices and are not computed as a unit value index. Nevertheless, we recalculate our results on the frequency and the size of price changes after excluding all items identified as problematic by Eichenbaum et al. (2014). The results are reported in Table B.3, Table B.4 and Table B.5. Comparing these results with Table 2 in the main text and Table B.8 in the appendix, we find that the differences are small. None of our conclusions on price-setting behavior is affected.

Table B.3: Frequency of price adjustments, excluding items identified as problematic by Eichenbaum et al. (2014)

	Frequency of price adjustments			
	Changes f	Increases f^+	Decreases f^-	Share Increases
Mean	26.1	13.8	12.3	55.7
Median	15.7	6.4	5.4	
Std. dev.	28.8	20.4	19.3	

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution but excludes all items identified as problematic by Eichenbaum et al. (2014). The frequencies of price "changes," "increases," and "decreases" refer to the weighted averages of the shares of price changes, increases, and decreases, respectively. The mean frequency of price changes is calculated by first computing the frequency of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Median statistics and statistics of standard deviations are calculated analogously. "Share of increases" refers to the share of price increases in all price changes. Frequencies of price adjustments are reported in percent per month.

Table B.4: Size of price adjustments, excluding items identified as problematic by Eichenbaum et al. (2014)

	Size of price adjustments			
	Average Changes Δp	Absolute Changes $\lvert\Delta p\rvert$	Increases Δp^+	Decreases Δp^-
Mean	0.4	11.4	10.7	-11.8
Median	0.7	8.1	7.3	-8.4
Std. dev.	11.9	10.8	11.0	11.6

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution but excludes all items identified as problematic by Eichenbaum et al. (2014). The sizes of "absolute" price changes, price "increases," and "decreases" refer to the weighted averages of the absolute size of price changes, size of price increases, and absolute size of price decreases, respectively. The mean size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Median statistics and statistics of standard deviations are calculated analogously. Price changes are reported in percent per month.

Table B.5: Distribution of the size of price adjustments, excluding items identified as problematic by Eichenbaum et al. (2014)

	Size of price adjustments				
	Changes Δp	Abs. changes $\|\Delta p\|$	Increases Δp^{+}	Decreases Δp^{-}	Stand. changes z
Mean	0.3	9.3	8.8	-9.8	0.7
10th percentile	-14.1	0.7	0.5	-35.7	0.1
25th percentile	-3.6	1.7	1.9	-21.6	0.2
50th percentile	0.6	4.1	6.2	-8.1	0.6
75th percentile	4.4	10.6	16.4	-1.8	1.0
90th percentile	13.3	23.9	33.7	-0.4	1.6
Standard deviation	20.9	16.5	16.7	16.4	0.7
Skewness	0.2				-0.0
Kurtosis	8.9				5.2

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution but excludes all items identified as problematic by Eichenbaum et al. (2014). The sizes of average price "changes," "absolute" price changes, price "increases," "decreases," and "standardized" price changes refer to the weighted averages of the average size of price changes, absolute size of price changes, size of price increases, size of price decreases, and size of standardized price changes, respectively. The mean size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Statistics of other moments are calculated analogously. Median statistics and statistics of standard deviations are calculated analogously. Price changes are reported in percent per month.

B.3 The frequency and size of price changes over time

To illustrate which components of the CPI are responsible for changes in the frequency and size of price adjustments over time, Table B.6 and Table B.7 show average moments for four sectors (food, NEIG, services, and energy) over the periods 2008 to 2010 and 2017 to 2019.

Table B.6: Frequency of price adjustments by sector: 2008–2010 and 2017–2019

	N	Frequency of price adjustments			CPI weight
		Changes	Increases	Decreases	
2008–2010					
Food	66	20.2	10.8	9.4	12.9
NEIG	79	11.9	6.6	5.3	19.4
Services	35	12.5	8.1	4.5	20.6
Energy	4	92.4	48.8	43.5	4.5
2017–2019					
Food	79	33.3	17.7	15.7	13.5
NEIG	93	19.8	10.4	9.4	16.2
Services	45	23.3	12.3	11.1	21.2
Energy	5	83.2	46.8	36.4	3.3

Notes: The samples range from January 2008 to December 2010 and from January 2017 to December 2019 and include price changes due to temporary sales and product substitution. "N" denotes the number of expenditure items. The frequency of price "changes," "increases," and "decreases" refer to the weighted averages of the share of price changes, increases, and decreases, respectively. The frequency of price changes is calculated by first computing the frequency of price changes for each variety and then taking a weighted mean across all varieties by sector using CPI expenditure weights. Frequencies are reported in percent per month.

Table B.7: Size of price adjustments by sector: 2008–2010 and 2017–2019

	N	Size of price adjustments			CPI weight
		Median	IQR	Kurtosis	
2008–2010					
Food	66	9.4	7.9	2.3	12.9
NEIG	79	13.1	9.5	2.1	19.4
Services	35	7.6	4.0	2.3	20.6
Energy	4	3.5	1.8	2.7	4.5
2017–2019					
Food	79	6.3	5.7	3.7	13.5
NEIG	93	12.8	12.0	2.8	16.2
Services	45	10.7	8.0	2.9	21.2
Energy	5	2.2	1.6	3.4	3.3

Notes: The samples range from January 2008 to December 2010 and from January 2017 to December 2019 and include price changes due to temporary sales and product substitution. "N" denotes the number of expenditure items. Moments are calculated at the variety level and aggregated using CPI expenditure weights. The median price change is calculated using absolute log-price changes, while the interquartile range is based on log-price changes. The kurtosis uses standardized price changes. Price changes are reported in percent per month.

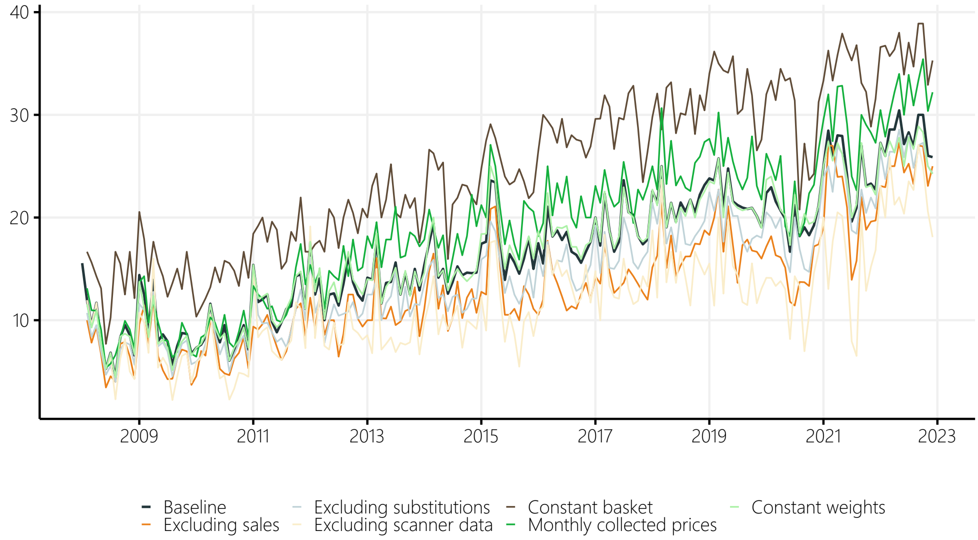
The variations in the frequency and size of price changes over time are shown in Figure 1 in the main text. In what follows, we examine whether the results shown in these figures are robust to alternative datasets. "Baseline" refers to the sample including temporary sales and product substitution used in Figure 1. "Excluding sales" refers to the sample excluding price changes related to temporary sales.

“Excluding substitutions” refers to the sample excluding price changes related to product substitution. “Excluding scanner data” refers to the sample excluding items collected by scanner. Scanner data were continuously introduced in 2008, 2010, 2012, and 2016. The price of an item collected via scanner data is calculated as the unit value price during the first 14 days of the month, i.e., the ratio of sales revenue from a product to the quantity sold. To the extent that there are temporary discounts, this generates spurious price changes. The “constant basket” is based on items that are consistently part of the basket of goods and services from 2008 to 2022 (and accordingly neglects items that are introduced or discontinued during the period). “Monthly collected prices” are based on prices that have been collected at only a monthly frequency since 2008. “Constant weights” uses time-invariant CPI weights (averaged over the sample period) in the aggregation.

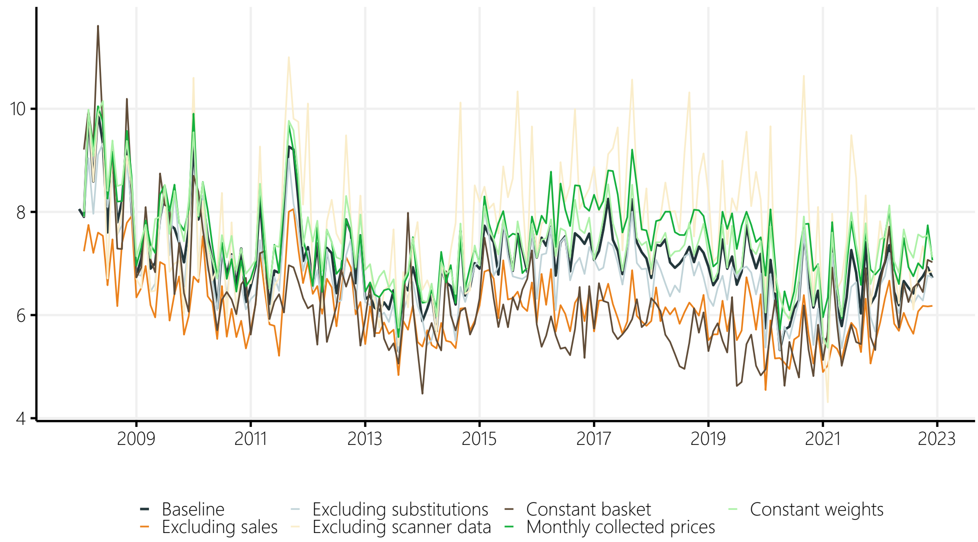
Figure B.1 plots the median frequency (top panel) and median absolute size (bottom panel) of price changes in CPI microdata from January 2008 to December 2022 for these alternative datasets. The lines in the top panel show an upward trend, whereas the lines in the lower panel are mostly flat. Therefore, our conclusions on the trends in the frequency and absolute size of price changes are robust to the alternative datasets considered here.

Figure B.1: Sensitivity of the frequency and size of price changes to different sample compositions

Frequency of price changes



Size of price changes

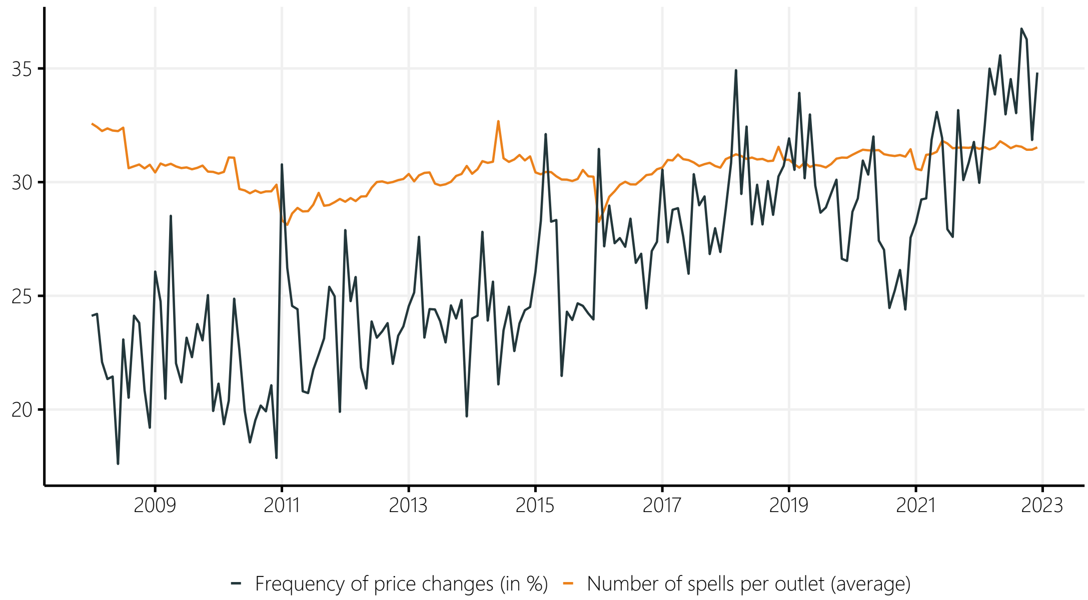


Notes:

Sensitivity of the median frequency (top panel) and absolute size of price changes (bottom panel) in Swiss CPI microdata from January 2008 to December 2022 across different sample compositions. All moments are depicted in percent per month.

Furthermore, we examine whether the upward trend in the frequency of price changes is related to an increase in the number of goods per outlet. Figure B.2 shows the average number of prices collected per outlet and month and the average frequency of price changes. We observe that the average number of prices collected per outlet varies little over time, while the frequency of price changes shows an upward trend. The correlation between the two series is positive but very low (Pearson correlation coefficient of +0.118). The correlation coefficient stays close to zero when calculating correlations at the level of main groups (not reported in Figure B.2).

Figure B.2: Number of spells and frequency of price changes



Notes: The figure shows the average frequency of price changes together with the number of spells per outlet for the sample, including temporary sales and product substitutions over the period from 2008 to 2019.

B.4 The distribution of price changes

Table B.8 summarizes various statistics on the distribution of non-zero price changes including temporary sales and product substitutions. Table B.9 provides the corresponding set of results for the sample excluding sales.

Table B.8: Distribution of the size of price adjustments

	Size of price adjustments				
	Changes Δp	Abs. changes $\lvert\Delta p\rvert$	Increases Δp^{+}	Decreases Δp^{-}	Stand. changes z
Mean	0.2	10.3	9.5	-11.2	0.7
10th percentile	-15.8	0.6	0.5	-35.7	0.1
25th percentile	-3.9	1.6	2.1	-21.1	0.2
50th percentile	0.5	4.3	6.9	-8.3	0.5
75th percentile	4.6	12.0	17.5	-2.0	1.0
90th percentile	15.4	28.0	34.8	-0.4	1.6
Standard deviation	21.0	16.5	16.7	16.4	0.7
Skewness	0.2				0.0
Kurtosis	8.8				5.2

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. The sizes of average price "changes," "absolute" price changes, price "increases," "decreases," and "standardized" price changes refer to the weighted averages of the average size of price changes, the absolute size of price changes, size of price increases, size of price decreases, and size of standardized price changes, respectively. The mean size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Statistics of other moments are calculated analogously. Price changes are reported in percent per month.

Table B.9: Distribution of the size of price adjustments based on the sample excluding temporary sales

	Size of price adjustments				
	Changes Δp	Abs. changes $\|\Delta p\|$	Increases Δp^+	Decreases Δp^-	Stand. changes z
Mean	0.3	8.6	8.0	-9.3	0.7
10th percentile	-12.5	0.6	0.4	-24.1	0.1
25th percentile	-3.4	1.5	1.7	-13.7	0.2
50th percentile	0.5	3.9	5.4	-5.9	0.5
75th percentile	4.3	9.9	13.3	-1.5	1.0
90th percentile	12.6	22.2	24.1	-0.4	1.7
Standard deviation	15.3	12.1	12.0	12.3	0.7
Skewness	0.2				-0.0
Kurtosis	13.8				5.6

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to product substitution but excludes price changes due to temporary sales. The sizes of average price "changes," "absolute" price changes, price "increases," "decreases," and "standardized" price changes refer to the weighted averages of the average size of price changes, the absolute size of price changes, size of price increases, size of price decreases, and size of standardized price changes, respectively. The mean size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean across all varieties using CPI expenditure weights. Statistics of other moments are calculated analogously. Price changes are reported in percent per month.

B.5 Alternative trimming of the data

The sampling decisions described in Section 2.6 restrict price changes in the data sample to price changes between the 1st percentile and the 99th percentile of the distribution of absolute log price changes. Table B.10 summarizes the statistics for the baseline (Case 0) and three alternative trimming thresholds. Statistics are given for the frequency and absolute size of price changes, the standard deviation, and the kurtosis. The kurtosis values reported in the table decrease when the lower threshold is more stringent.

Table B.10: Robustness of price-setting moments to outlier trimming

Case	Type of trimming	Obs.	f	$\|\Delta p\|$	sd($\|\Delta p\|$)	Kur(z)
0	$P1 < \|\Delta p\| < P99$	1732936	26.16	11.13	10.66	5.19
1	$0.5\% < \|\Delta p\| < P99$	1560931	23.89	11.91	10.67	4.68
2	$1\% < \|\Delta p\| < P99$	1446091	22.11	12.55	10.71	4.35
3	$P1 < \|\Delta p\| < 100\%$	1729302	26.12	11.02	10.33	5.16

Notes: Robustness of price-setting moments to outlier treatment. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. Case 0 corresponds to the trimming applied in the baseline sample in the main text. "Obs." denotes the number of price changes, f denotes the monthly frequency of price changes in percent, $|\Delta p|$ is the absolute size of price changes, sd($|\Delta p|$) is the standard deviation of the absolute size of price changes, and Kur(z) denotes the kurtosis of the standardized price changes. Moments are aggregated using CPI expenditure weights.

B.6 Comparison with evidence on price setting in the United States

This section provides more details on the methodology and the results of comparing of our findings on price rigidity in Switzerland with evidence for the United States provided by Nakamura and Steinsson (2008) for the period 1998–2005.

To secure a consistent comparison and control for possible differences in the composition of the consumption baskets, we perform the comparison based on a restricted sample of products represented in both countries. Furthermore, we use US CPI expenditure weights to calculate the aggregate statistics for both economies. We start from the disaggregated results on the frequency and size of price changes that are part of the supplementary material by Nakamura and Steinsson (2010). These results are available from 1998 to 2005 based on samples including and excluding temporary sales (product substitutions are excluded in both samples). To determine the sample of comparable products, we create a correspondence table between the Entry Level Items (ELIs) classification of the US CPI and the COICOP classification of the Swiss CPI (we map ELIs into COICOP at the five-digit level).

We exclude 16 ELIs (accounting for 3.1 percent of the US consumption basket), for which we do not find an appropriate correspondence in the five-digit COICOP categories. These ELIs are dogs (RB012), automobile service clubs (TF032), housing at school, excluding board (HB011), replacement of setting for women's rings (GD043), calculators and adding machines (EE042), gardening or lawn care services (HP021), reupholstery of furniture (HP042), Spanish/Mexican foods (FT062), rental of video tapes and discs (RA042), peanut butter (FS031), moving, storage, freight express (HP031), appliance repair (HP041), motor oil (TC022), alternative automotive fuels (TB022), vehicle leasing (TA031) and automobile rental (TA041).

Furthermore, we exclude 5 five-digit COICOP categories (accounting for 8.2 percent of the US consumption basket) for which underlying prices are collected using a different method in one country (e.g., as a unit value index or administered prices) than in the other. These COICOP categories are electricity (04.5.1), gas (04.5.2), other health related incurred costs (06.6.1), recording media (09.1.4), and books (09.5.1).

Table B.11 and the upper panels of Figure B.3 present the comparison results for the frequency of price changes. Results are given for the mean and median frequencies of price changes and samples including and excluding temporary sales. Price changes due to product substitution are excluded in all samples. The corresponding results for the absolute size of price changes are presented in Table B.12 and in the lower panels of Figure B.3.

Table B.11: Frequency of price adjustments: Switzerland versus United States

	Including sales				Excluding sales			
	Mean		Median		Mean		Median	
	CH	US	CH	US	CH	US	CH	US
Total	20.6	25.8	11.9	20.4	19.1	20.2	8.7	8.4
Food	28.0	31.3	25.9	32.9	26.6	17.7	24.8	13.1
NEIG	19.9	28.6	13.8	25.9	15.5	17.7	5.0	6.4
Energy	82.7	85.4	82.9	87.6	82.5	85.4	82.7	87.6
Services	11.1	15.2	5.6	7.8	11.0	14.9	5.6	7.8

Notes: The table shows the mean and median frequencies of price adjustments in percent per month for Switzerland and the United States. The results for Switzerland are based on the period from January 2008 to December 2022. The results for the US are taken from Nakamura and Steinsson (2010) and calculated for the period 1998–2005. To control for possible differences in the composition of the consumption basket across economic areas, the comparison uses the same equivalent products and US CPI expenditure weights to calculate the aggregate statistics. Both samples exclude price changes due to product substitution. Temporary sales are excluded using sales flags by the respective national statistical offices.

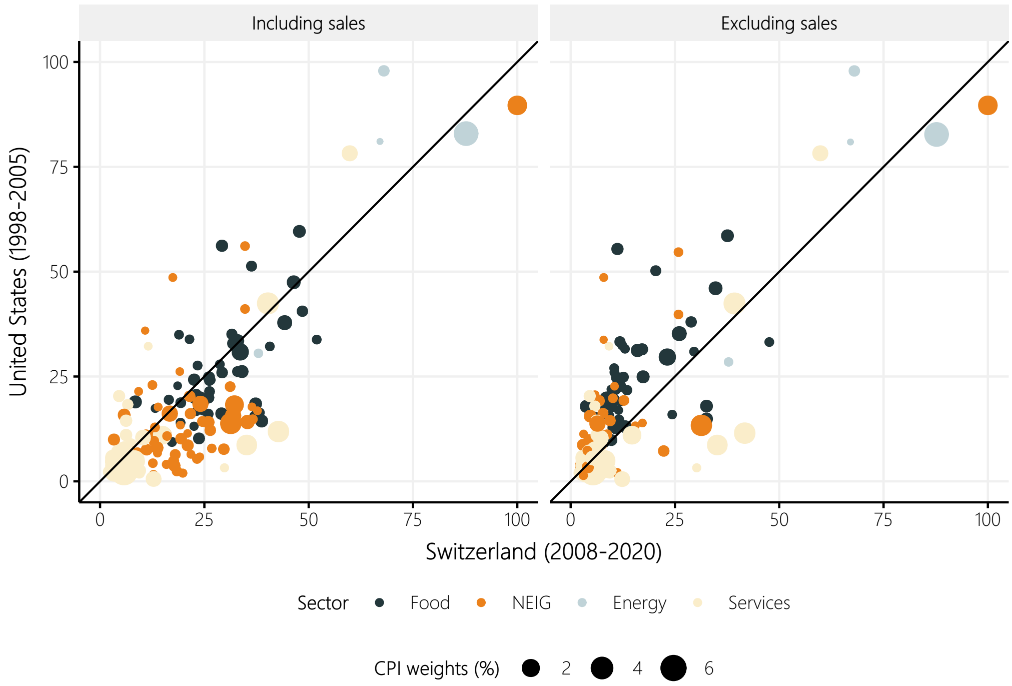
Table B.12: Absolute size of price adjustments: Switzerland versus United States

	Including sales						Excluding sales					
	Changes		Increases		Decreases		Changes		Increases		Decreases	
	CH	US	CH	US	CH	US	CH	US	CH	US	CH	US
Total	10.9	15.3	10.6	14.2	10.9	17.3	7.9	10.7	7.5	10.1	8.5	12.5
Food	7.8	24.8	7.6	23.4	7.9	26.6	6.4	13.7	6.2	12.6	6.4	16.0
NEIG	15.8	18.4	14.4	16.6	15.8	19.7	8.0	9.7	7.4	9.3	8.8	10.7
Energy	2.4	6.6	2.1	7.0	2.2	6.0	2.3	6.6	2.0	7.0	2.1	6.0
Services	10.0	11.1	10.5	10.4	10.0	13.7	9.1	10.6	8.8	10.0	10.0	13.0

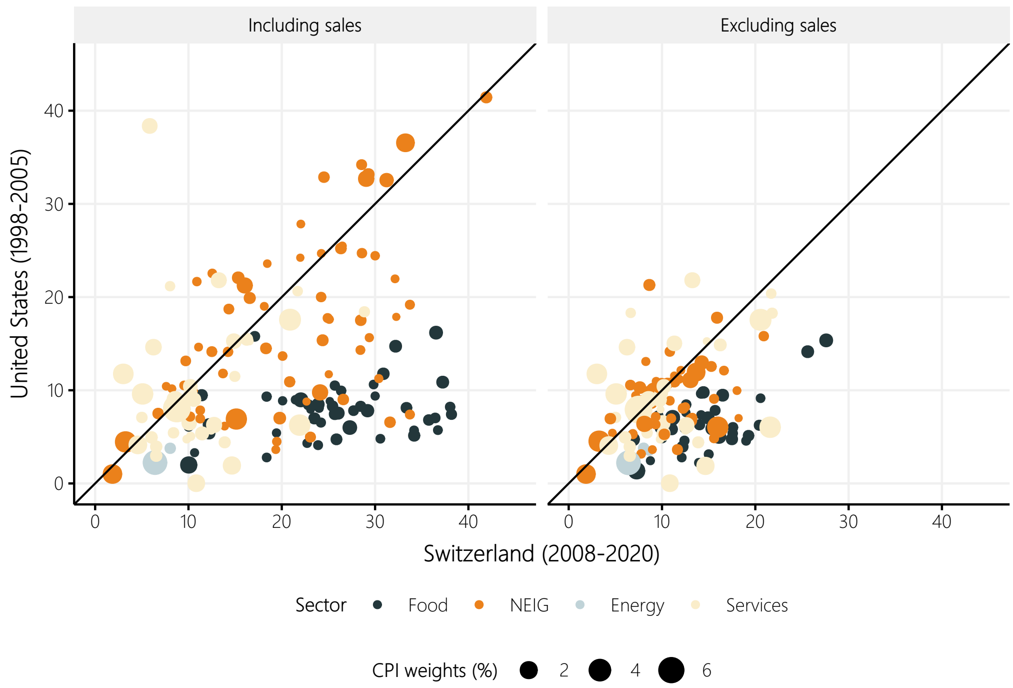
Notes: The table shows the average absolute size of price changes, increases, and absolute decreases in percent per month for Switzerland and the United States. The results for Switzerland are based on the period from January 2008 to December 2022. The results for the US are taken from Nakamura and Steinsson (2010) and calculated for the period 1998–2005. To control for possible differences in the composition of the consumption basket across economic areas, the comparison uses the same equivalent products and US CPI expenditure weights to calculate the aggregate statistics. Both samples exclude price changes due to product substitution. Temporary sales are excluded using sales flags by the respective national statistical offices.

Figure B.3: Frequency and size of price changes: Switzerland versus the United States

Frequency of price changes



Size of price changes



Notes: These figures plot the frequency (upper panels) and size of price changes (lower panels) for the samples including and excluding temporary sales for Switzerland and the United States. The results for Switzerland are based on the period from January 2008 to December 2022. The results for the US are taken from Nakamura and Steinsson (2010) and calculated for the period 1998–2005. To control for possible differences in the composition of the consumption basket across economic areas, the comparison uses the same equivalent products and US CPI expenditure weights to calculate the aggregate statistics. Both samples exclude price changes due to product substitution. Temporary sales are excluded using sales flags by the respective national statistical offices. All moments are depicted in percent.

For the sample including sales, we find that prices are on average more flexible in the United States than in Switzerland. The average frequency of price adjustments is 25.8 percent in the US, whereas it is 20.6 percent for comparable goods and services in Switzerland (see Table B.11). However, when we exclude temporary sales, the frequencies of price changes are approximately the same in both countries: 20.2 percent in the US and 19.1 percent in Switzerland. The same pattern applies to the median frequencies of price changes. Examining the sectoral differences, we observe that the frequency of food price changes is significantly higher in Switzerland than in the US (+9 percentage points excluding temporary sales). This difference could partly be because in Switzerland, the prices of most food items have been collected as scanner data since 2008, which leads to more frequent price changes (Cavallo, 2018b). In all other sectors, the price adjustment frequency in the US exceeds that in Switzerland by 2 to 3 percentage points.

Turning to the size of price changes, we find that price changes in the US are, on average, significantly larger than in Switzerland. For the sample including temporary sales, the average absolute price change is 15.3 percent in the US and 10.9 percent in Switzerland (see Table B.12). When we exclude price changes due to temporary sales, we find that the size of price changes in both countries is slightly closer: 10.7 percent in the United States versus 7.9 percent in Switzerland. Price changes in the food and energy sector are more than twice as large in the US than in Switzerland. For food items, this could again be related to the use of scanner data, which are usually associated with smaller price changes (Cavallo, 2018b). For NEIG and services, the size of price changes in the US exceeds that in Switzerland by approximately 2 percentage points.

B.7 Comparison with evidence on price setting in the euro area

This section provides more details on the methodology and the results of comparing our findings on price rigidity in Switzerland with evidence for the euro area provided by Gautier et al. (2024).

Gautier et al. (2024) use CPI microdata from eleven euro area countries and build a harmonized sample of 166 common products at the five-digit COICOP level. The 166 common products are items for which data are available in at least three of the four largest euro area countries (Germany, France, Italy, and Spain). They calculate results on the frequency and size of price changes over the common period from 2011 to 2017 across all countries, except for Belgium (2011–2015) and Latvia (2017).

Gautier et al. (2024) do not publish disaggregated results on the frequency and size of price changes. Therefore, we restrict our sample to 155 of the 166 common products, which are also represented in our Swiss data.[31] The 11 five-digit COICOP categories missing from the Swiss data account for only 1.8 percent of the 166 common products in the euro area by expenditure weight, which leaves our comparison broadly representative. The sample of products represented in both economic areas covers 53.0 percent of the 2022 Swiss CPI basket. We further restrict the sample period to 2011–2017 to compare moments of price rigidity on a common period in all euro area countries (except Belgium: 2011–2015; Latvia: 2017) and Switzerland. Furthermore, we use the same euro area HICP weights averaged over 2017–2020 to aggregate our five-digit COICOP-level results for Switzerland.

The 11 COICOP categories missing in our data for Switzerland are fresh or chilled seafood (01.1.3.3), frozen seafood (01.1.3.4), other preserved or processed fish and seafood-based preparations (01.1.3.6), milk, preserved (01.1.4.3), repair of furniture, furnishings and floor coverings (05.1.3.0), repair of household appliances (05.3.3.0), thermal-baths, corrective-gymnastic therapy, ambulance services and hire of therapeutic equipment (06.2.3.2), lubricants (07.2.2.4), removal and storage services (07.3.6.2), museums, libraries, zoological gardens (09.4.2.2), and accommodation services of other establishments (11.2.0.3).

[31] We thank the authors for providing us with the list of 166 common products covered in Gautier et al. (2024).

Table B.13 presents the comparison results for the frequency of price changes. Results are given for the mean and median frequencies of price changes and for samples including and excluding temporary sales. Price changes due to product substitution are excluded in all samples. The corresponding results for the size of price changes are presented in Table B.14.

Table B.13: Frequency of price adjustments: Switzerland versus euro area

	Including sales				Excluding sales			
	Mean		Median		Mean		Median	
	CH	EA	CH	EA	CH	EA	CH	EA
Total	15.2	11.9	12.8	9.6	12.9	8.3	7.4	5.7
Processed food	48.4	31.1	50.4	29.3	46.9	23.4	49.3	20.2
Unprocessed food	21.4	14.9	21.6	14.4	20.2	10.2	19.9	8.5
NEIG	12.6	12.4	14.5	12.0	6.5	6.3	3.3	5.1
Services	7.1	5.6	4.3	3.2	7.0	5.4	4.1	3.0

Notes: The table shows the mean and median frequencies of price adjustments in percent per month for Switzerland and the euro area. The results for the euro area are taken from Gautier et al. (2024) and calculated for the period 2011–2017 (Belgium: 2011–2015; Latvia: 2017) using a harmonized sample of 166 common products. The results for Switzerland are based on the same period and 155 of the 166 common products, representing 98.2% of their expenditure. Results for both economic areas use euro area HICP weights averaged over the period 2017–2020 to aggregate five-digit COICOP-level results to control for possible differences in consumption patterns. Both samples exclude price changes due to product substitution. Temporary sales are excluded using sales flags by the respective national statistical offices.

Table B.14: Absolute size of price adjustments: Switzerland versus euro area

	Including sales				Excluding sales			
	Increases		Decreases		Increases		Decreases	
	CH	EA	CH	EA	CH	EA	CH	EA
Total	11.8	9.0	12.9	12.0	7.9	6.4	9.3	8.0
Processed food	9.8	12.3	9.7	14.5	8.8	10.0	8.6	10.6
Unprocessed food	6.9	8.3	7.2	10.4	5.3	5.7	5.6	6.1
NEIG	20.2	13.5	21.1	18.4	9.2	7.8	11.9	10.2
Services	8.1	5.0	10.0	6.5	7.9	5.0	9.5	6.2

Notes: The table shows the median size of price increases and absolute price decreases in percent per month for Switzerland and the euro area. The results for the euro area are taken from Gautier et al. (2024) and calculated for the period 2011–2017 (Belgium: 2011–2015; Latvia: 2017) using a harmonized sample of 166 common products. The results for Switzerland are based on the same period and 155 of the 166 common products, representing 98.2% of their expenditure. Results for both economic areas use euro area HICP weights averaged over the period 2017–2020 to aggregate five-digit COICOP-level results to control for possible differences in consumption patterns. Both samples exclude price changes due to product substitution. Temporary sales are excluded using sales flags by the respective national statistical offices.

The comparison shows that prices are more flexible in Switzerland than in the euro area. The average frequency of price adjustments including temporary sales is 15.2 percent in Switzerland, whereas it is 11.9 percent in the euro area (see Table B.13). The results for Switzerland are comparable to those for Latvia (15.9 percent), Lithuania (13.3 percent), and Greece (12.7 percent), the countries for which

Gautier et al. (2024) find the highest frequencies of price changes in the euro area. When temporary sales are excluded, the respective adjustment frequencies are 12.9 percent for Switzerland and 8.3 percent for the euro area. These findings also apply to the median frequencies of price changes.

Furthermore, while we observe a considerable increase in the frequency of price changes from 2008 to 2019 in Switzerland, the results for the euro area do not show any strong upward trend over the period from 2005 to 2019.

With respect to the size of price changes, we find that price changes in Switzerland are, on average, slightly larger than those in the euro area. For the sample including temporary sales, the median absolute size of price increases (decreases) is 11.8 percent (12.9 percent) in Switzerland, compared to 9.0 percent (12.0 percent) in the euro area (see Table B.14). When we exclude price changes due to temporary sales, the difference is smaller for price increases (7.9 percent in Switzerland versus 6.4 percent in the euro area) but larger for absolute price decreases (9.3 percent versus 8.0 percent). Examining the sectoral differences, we note that while price changes for NEIG and services are larger in Switzerland, price changes for food are larger in the euro area.

B.8 Cross-sectional heterogeneity in the frequency and size of price changes

Table B.15: Frequency of price adjustments by sector

	Coverage	Mean frequency of price adjustments			Median frequency of price adjustments			Sales	Substitution
		Changes f	Increases f^+	Decreases f^-	Changes f	Increases f^+	Decreases f^-		
Food	13.2	29.5	15.6	13.9	26.3	12.6	10.6	1.3	1.3
Unprocessed food	3.6	45.6	23.0	22.7	43.4	20.4	19.6	1.5	2.7
Processed food	9.6	23.9	13.1	10.8	20.9	10.3	8.6	1.2	0.8
NEIG	17.6	17.2	8.9	8.2	12.5	5.1	4.9	6.1	4.2
Durable goods	7.8	18.6	9.8	8.8	13.9	5.3	4.5	6.0	4.2
Semi-durable goods	7.4	16.8	8.4	8.5	12.5	5.0	5.6	7.8	5.4
Non-durable goods	2.4	12.9	7.4	5.5	10.6	5.4	3.9	1.9	0.8
Energy	3.7	87.0	45.9	41.1	97.4	48.1	40.9	0.2	0.2
Services	19.6	16.8	9.5	7.3	3.4	2.1	0.0	0.2	2.1
Housing	1.5	24.4	16.9	7.5	22.7	15.3	5.4	0.0	0.9
Transport	1.7	57.6	32.5	25.1	71.4	36.2	29.3	0.0	0.2
Communication	2.6	7.2	4.4	2.8	0.0	0.0	0.0	0.0	2.0
Recreation	13.0	15.1	8.3	6.7	3.6	2.5	0.0	0.2	2.3

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. “Coverage” indicates the average CPI expenditure weight of the sector over the sample period. The frequency of price “changes,” “increases,” and “decreases” refer to the weighted averages (medians) of the share of price changes, increases, and decreases, respectively. The frequency of price changes is calculated by first computing the frequency of price changes for each variety and then taking a weighted mean (median) across all varieties by sector using CPI expenditure weights. “Sales” denotes the share of sales price observations in all price quotes. “Substitution” denotes the share of product substitutions in all price quotes. Frequencies of price adjustments are reported in percent per month. Sectors correspond to the COICOP-HICP special aggregates by Eurostat. Food includes alcohol and tobacco. Services correspond to the overall index excluding goods (i.e., food, non-energy industrial goods, and energy). Services related to recreation also include repairs and personal care.

Table B.16: Size of price adjustments by sector

		Mean size of price adjustments				Median size of price adjustments			
	Coverage	Average Changes Δp	Absolute Changes $\lvert\Delta p\rvert$	Increases Δp^+	Decreases Δp^-	Average Δp	Absolute Changes $\lvert\Delta p\rvert$	Increases Changes Δp^+	Decreases Δp^-
Food	13.2	0.1	8.3	8.1	-8.4	0.2	7.0	6.3	-6.5
Unprocessed food	3.6	0.0	10.4	10.2	-10.1	0.1	8.5	8.2	-8.3
Processed food	9.6	0.2	7.4	7.3	-7.7	0.2	6.3	5.4	-5.6
NEIG	17.6	0.0	16.7	16.0	-16.0	0.0	13.6	11.8	-12.8
Durable goods	7.8	-0.4	12.9	12.8	-13.1	-0.2	11.5	10.0	-10.5
Semi-durable goods	7.4	0.4	22.3	21.0	-20.4	0.2	19.8	16.2	-17.3
Non-durable goods	2.4	0.2	11.6	11.1	-12.0	0.2	9.3	8.3	-9.4
Energy	3.7	0.0	2.8	2.4	-2.4	0.2	2.2	1.8	-1.7
Services	19.6	0.1	12.7	11.8	-13.4	0.5	10.6	9.3	-11.1
Housing	1.5	1.1	4.7	4.5	-5.1	1.4	4.3	4.0	-4.6
Transport	1.7	0.4	19.6	18.8	-20.2	0.4	19.1	17.2	-20.9
Communication	2.6	-1.4	12.0	12.2	-13.1	-0.7	12.4	10.7	-7.5
Recreation	13.0	-0.0	12.0	11.0	-12.7	0.4	10.1	8.8	-10.8

Notes: The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. “Coverage” indicates the average CPI expenditure weight of the sector over the sample period. The size of “average” price changes, “absolute” price changes, price “increases,” and “decreases” refer to the weighted averages (medians) of the average size of price changes, the absolute size of price changes, the size of price increases and the size of price decreases, respectively. The mean (median) size of average price changes is calculated by first computing the average size of price changes for each variety and then taking a weighted mean (median) across all varieties by sector using CPI expenditure weights. Price changes are reported in percent per month. Sectors correspond to the COICOP-HICP special aggregates by Eurostat. Food includes alcohol and tobacco. Services correspond to the overall index excluding goods (i.e., food, non-energy industrial goods, and energy). Services related to recreation also include repairs and personal care.

C Price setting before the pandemic

This appendix refers to Section 4 in the main body of the paper and presents additional analyses that are not featured in the main text.

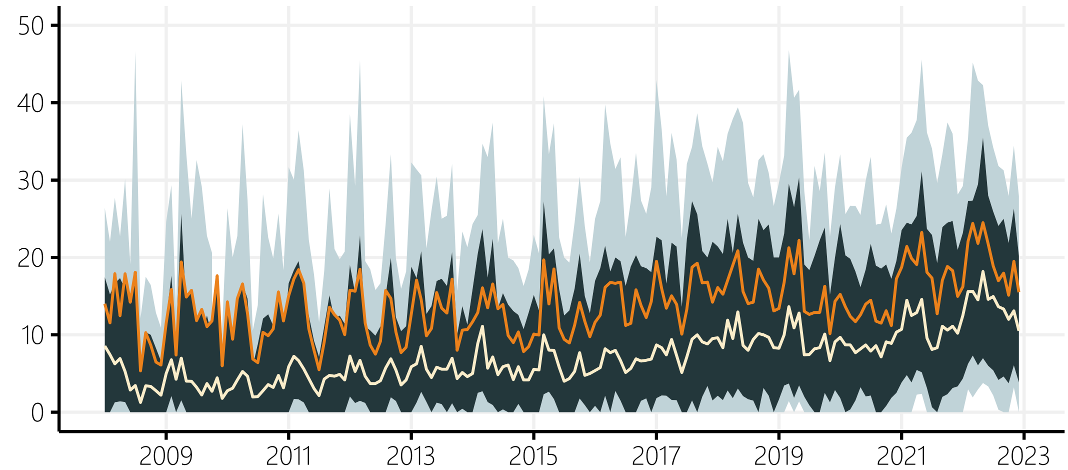
C.1 The frequency and size of price increases and decreases over time

The temporal variations in both the frequency and magnitude of price changes are illustrated in Figure 1 of the main text. To further examine how these characteristics evolve over time, Figure C.1 presents the cross-sectional distributions of the frequencies of price increases and decreases, while Figure C.2 shows the corresponding distributions of the magnitudes of these changes. Notably, the trend in the frequency of price changes reflects equal contributions from both price increases and decreases. In contrast, the magnitude of price changes shows no significant trend, with the sizes of both increases and decreases remaining relatively stable over time.

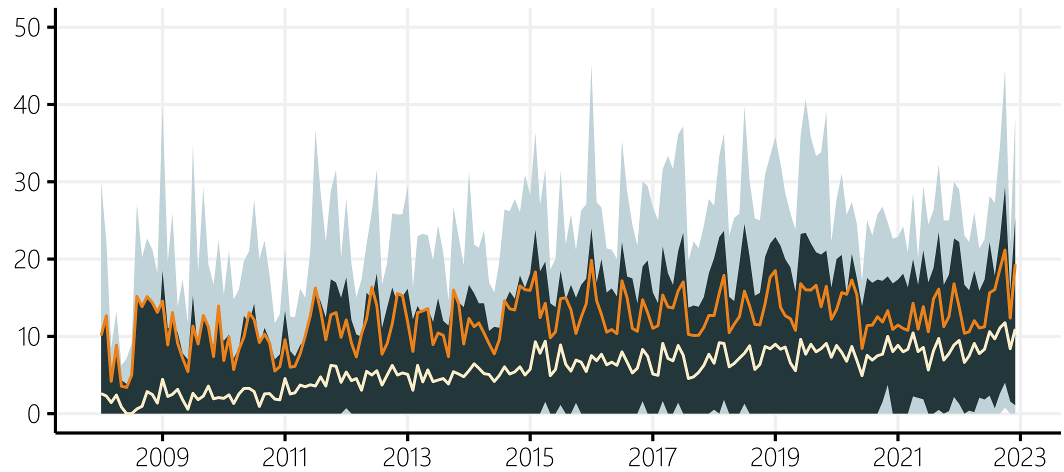
C.2 Frequency of online and offline price changes

Figure C.1: Distribution of the frequency of price increases and decreases across varieties over time

Frequency of price increases



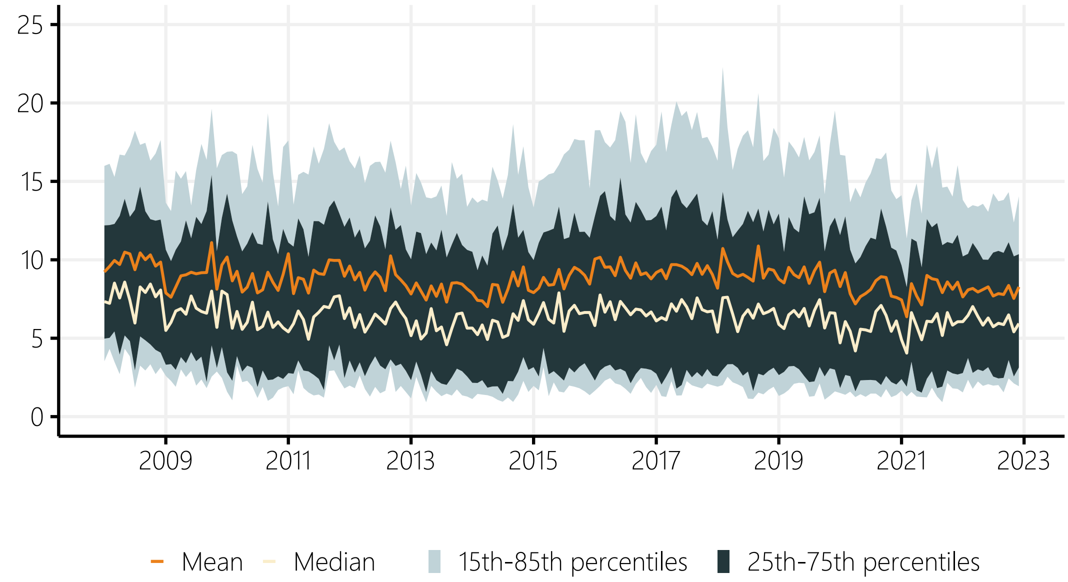
Frequency of price decreases



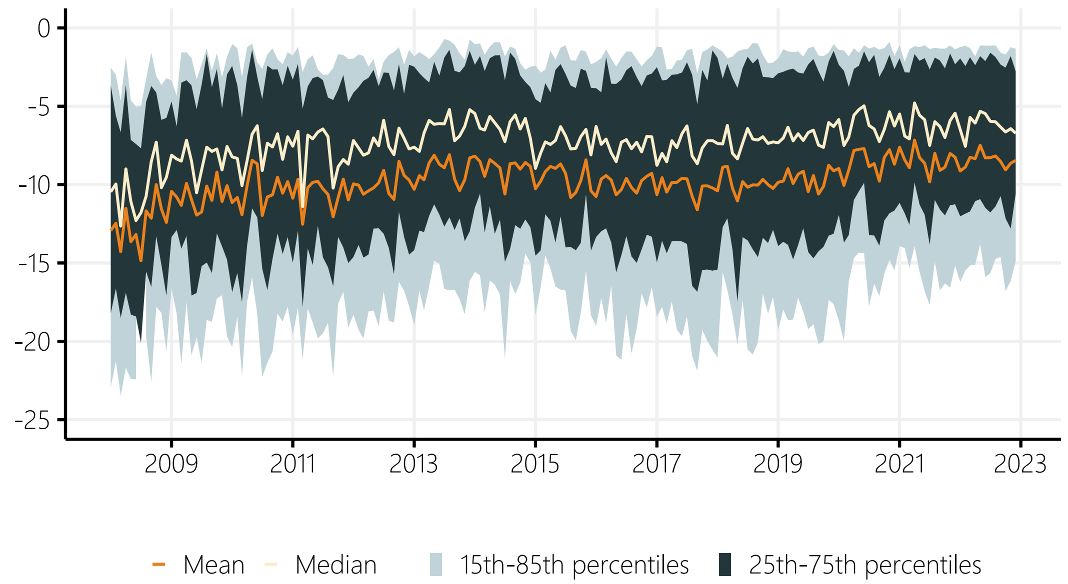
Notes: Distribution of the frequency of price increases (top panel) and decreases (bottom panel) across varieties in Swiss CPI microdata over time. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. The figure depicts the mean, the median, the interquartile range (dark-shaded areas), and the 15th-85th percentile range (light-shaded areas). Moments are reported in percent per month.

Figure C.2: Distribution of the size of price increases and decreases across varieties over time

Size of price increases

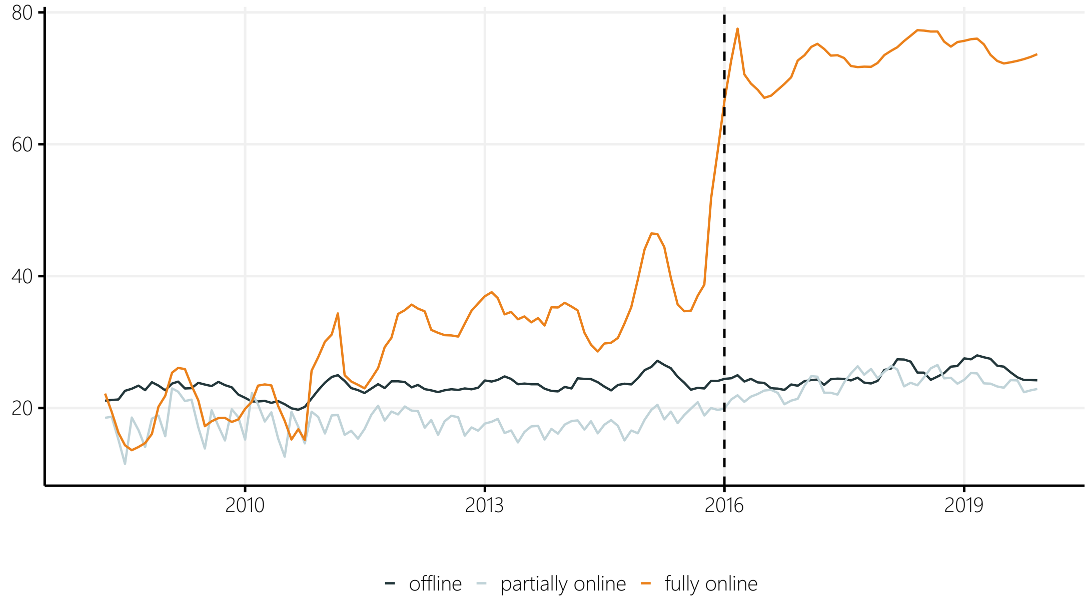


Size of price decreases



Notes: Distribution of the size of price increases (top panel) and decreases (bottom panel) of across varieties in Swiss CPI microdata over time. The sample ranges from January 2008 to December 2022 and includes price changes due to temporary sales and product substitution. The figure depicts the mean, the median, the interquartile range (dark-shaded areas), and the 15th-85th percentile range (light-shaded areas). Moments are reported in percent per month.

Figure C.3: Frequency of online and offline price changes



Notes: Frequency of price adjustments for items collected "fully online," "partially online," and for all remaining items ("offline"). All series are plotted as moving averages over the previous and the next two months and reported in percent.

D Price setting during the pandemic

This appendix refers to Section 5 in the main body of the paper and presents additional analyses that are not featured in the main text.

D.1 Cross-sectional heterogeneity in the frequency and size of price changes

To gain insight into the cross-sectional heterogeneity of the response of price-setting behavior to the COVID-19 shock, we examine the frequency and the size of price changes across sectors. Figure D.1 shows the frequency of price changes for food, NEIG, and services, again for all price changes (in the top row) and then separately for price increases (in the middle row) and price decreases (in the bottom row).

For food items, the frequency of price changes in 2020 did not deviate much from the average of the previous two years. However, distinguishing between price increases and decreases reveals that the frequency of price increases increased, and the frequency of price decreases decreased, suggesting a response of retail food pricing to the excess demand during the pandemic, particularly in the spring of 2020 (see Figure 4). In 2021 and 2022, the frequency of price changes increased significantly, driven by more frequent price increases. The frequency of price increases peaked at 25.6 percent in May 2022, exceeding its pre-pandemic average by 8.4 percentage points.

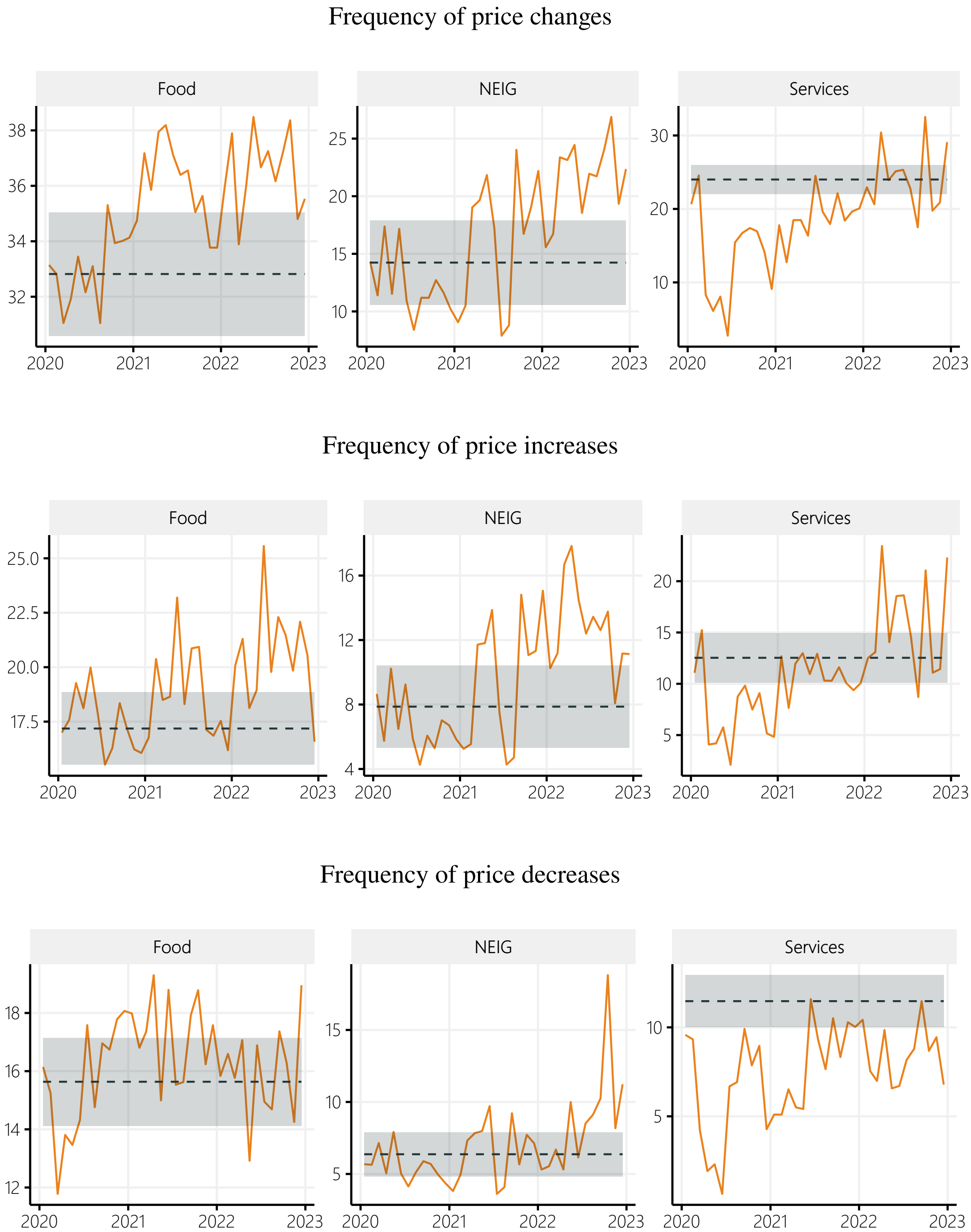
In the case of NEIG, retailers changed their prices at a similar frequency in 2020 as in the two years prior to the pandemic. In 2021 and 2022, the frequency of price increases contributed to the rise in the overall frequency of price changes. In April 2022, the frequency of price changes reached 23.1 percent, with price increases occurring more than twice as often as the pre-pandemic average.

In services, where the decline in demand resulting from the various containment measures was most severe and prolonged, the frequency of price changes dropped significantly. The largest declines occurred in the spring of 2020 and winter of 2021, coinciding with increasing numbers of COVID-19 cases and more stringent containment measures. While the frequency of price decreases remained below its pre-pandemic average from 2020 to 2022, the frequency of price increases exceeded its pre-pandemic average from early 2022 onward.

Looking at the same set of graphs for the size of price changes in Figure D.2, we notice a significant decline in the size of price changes for NEIG and services throughout the pandemic. The absolute size of price changes was smaller in almost every month than before the pandemic. When we distinguish between price increases and price decreases, we find that both price increases and price decreases were smaller on average compared to the two previous years.

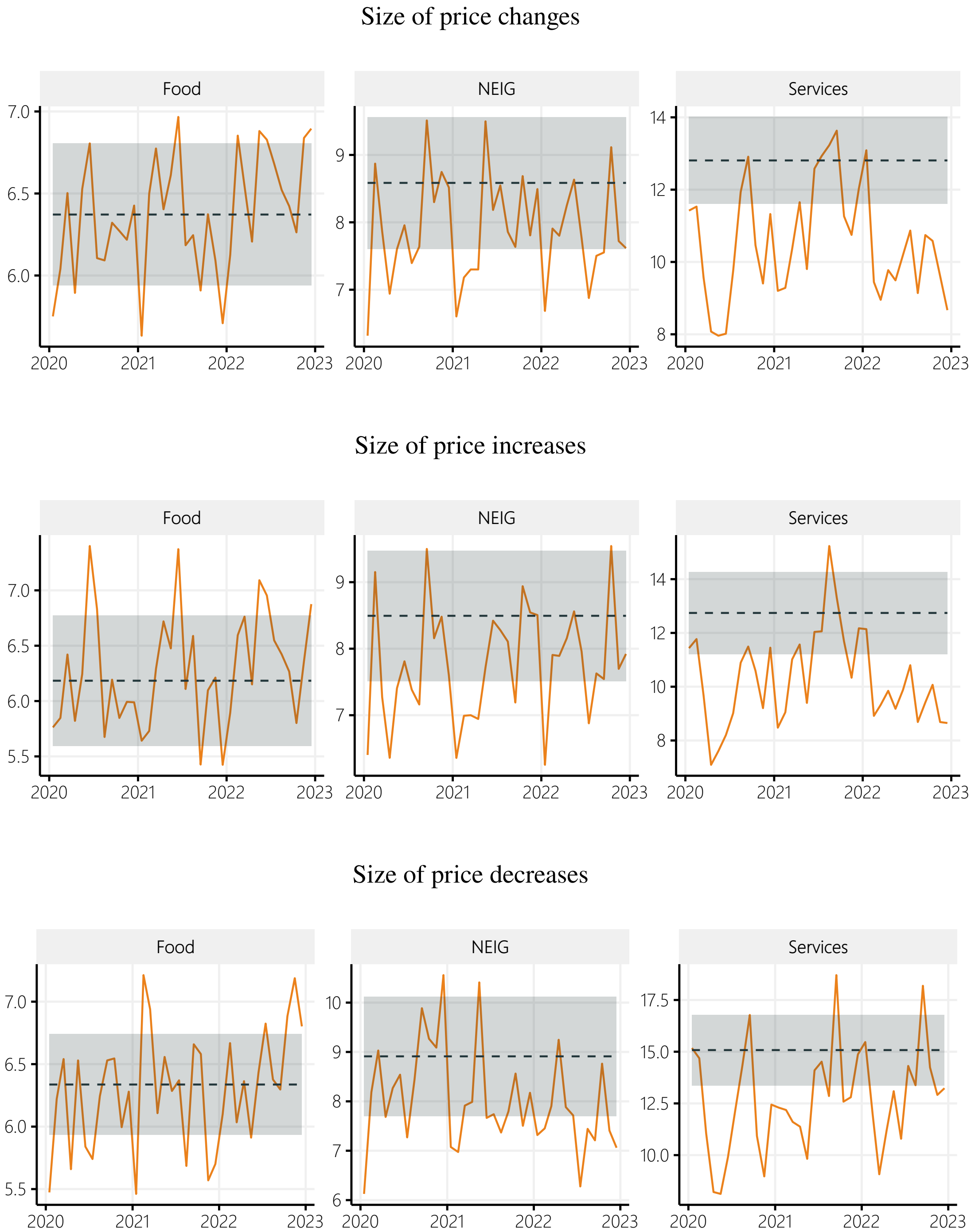
Evaluating the frequency and size of price changes during the pandemic shows heterogeneous responses of Swiss price setters to the COVID-19 shock across sectors. This is in line with Henkel et al. (2023), who analyze national CPI microdata for Germany, Italy, Latvia and Slovakia, and show pronounced differences across sectors and countries in how price setting responded to the pandemic. By contrast, the response of Swiss firms to the surge in inflation in 2022 is much more uniform and harmonized, driven by a broad-based increase in the frequency of price increases across sectors.

Figure D.1: Frequency of price changes, increases, and decreases across sectors during the pandemic



Notes: This figure shows the frequency of price changes (in the top row), price increases (in the middle row), and price decreases (in the bottom row) across sectors during the pandemic from January 2020 to December 2022. The shaded areas show the mean of the respective measures from January 2018 to December 2019 and the dispersion measured as the standard deviation around the mean (resulting in two-standard-deviation bands). The sample includes temporary sales and product substitutions but excludes COVID imputations. All moments are reported in percent per month.

Figure D.2: Size of price changes, increases, and decreases across sectors during the pandemic



Notes: This figure shows the absolute size of price changes (in the top row), price increases (in the middle row), and price decreases (in the bottom row) across sectors during the pandemic from January 2020 to December 2022. The shaded areas show the mean of the respective measures from January 2018 to December 2019 and the dispersion measured as the standard deviation around the mean (resulting in two-standard-deviation bands). The sample includes temporary sales and product substitutions but excludes COVID imputations. All moments are reported in percent per month.

E Price-setting behavior and inflation dynamics

This appendix refers to Section 6 in the main body of the paper and presents additional analyses that are not featured in the main text.

E.1 Data sources for shocks in local projections

This section provides more information on the shocks used in the estimations of linear and nonlinear local projections.

Oil supply news shocks The oil supply news shocks are the shocks in futures prices around OPEC announcements extracted from the VAR from Känzig (2021). The shock series is regularly updated and currently spans from 1975:01 to 2024:06. The frequency of the series is monthly.

The IRFs are rescaled to produce an inflation reaction to a 10 percent increase in monthly Brent crude oil price changes.

Swiss franc safe haven shocks The Swiss franc safe haven shocks (Boneva, 2024) are approximated as the changes in a safe haven indicator (SHI) that is constructed as the first principal component from Friday-to-Friday changes in the Swiss franc and a set of financial market variables that typically rise or fall markedly during flight-to-safety episodes (Japanese yen, US dollar, VIX, gold price, 10-year US Treasury term premium, 10-year CH government bond term premium and the EA peripheral spread). The SHI is an unpublished weekly series that is regularly updated by SNB staff.

The IRFs are rescaled to produce an inflation reaction to a 10 percent depreciation of the Swiss franc against the euro. Hence, we reverse the Swiss franc safe haven shocks.

Global demand shocks The global demand shocks are the shocks to economic activity estimated using the methodology of Baumeister and Hamilton (2019). The shock series is regularly updated and currently spans from 1975:02 to 2024:06. The frequency of the series is monthly.

The IRFs are rescaled to produce an inflation reaction to a 10 percent increase in monthly changes in industrial production.

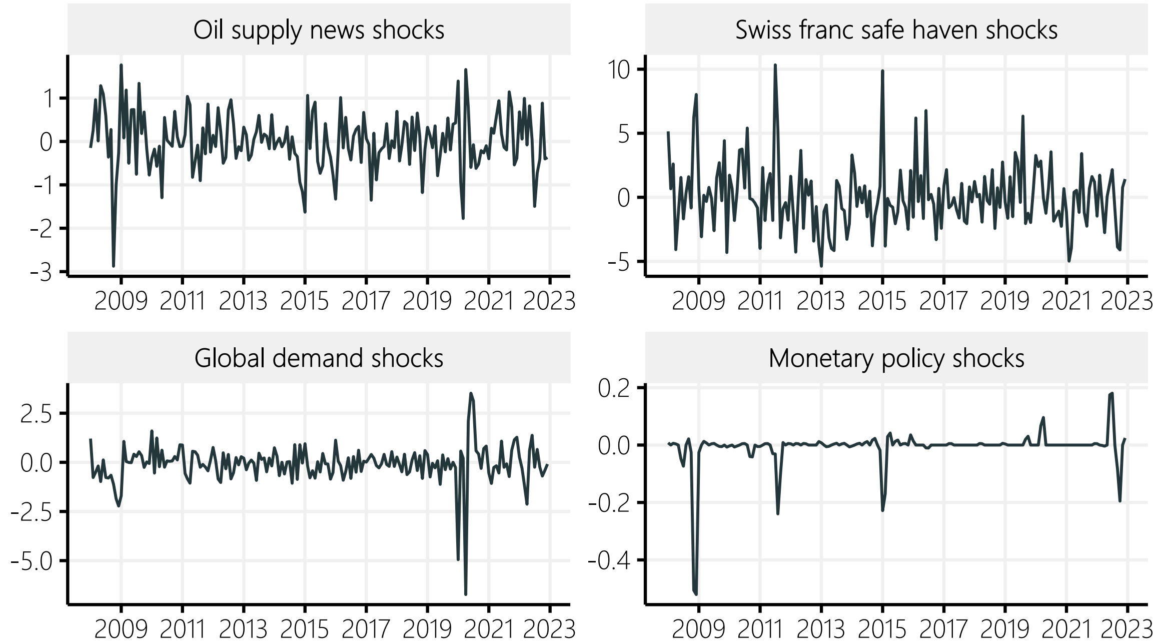
Monetary policy shocks The monetary policy shocks are provided by Nitschka and Oktay (2023), applying the identification approach of Bu et al. (2021) and Ciminelli et al. (2022) for Switzerland. The shock series spans from 20 January 2000 to 23 March 2023. The frequency of the series is daily. To convert the series into monthly average shocks for estimation in the monthly local projections model, we follow Gertler and Karadi (2015) and, first, cumulate shocks on any event day over the last 31 days and, second, average these monthly shocks over each day of the month.

The IRFs are rescaled to produce an inflation reaction to a positive surprise in the 3-month EONIA swap rate of 25 basis points.

E.2 Robustness to treatment of price changes due to temporary sales and product substitution

The results presented in the main body of the paper rely on the baseline sample that includes price changes due to temporary sales and product substitution. This section analyzes the robustness of

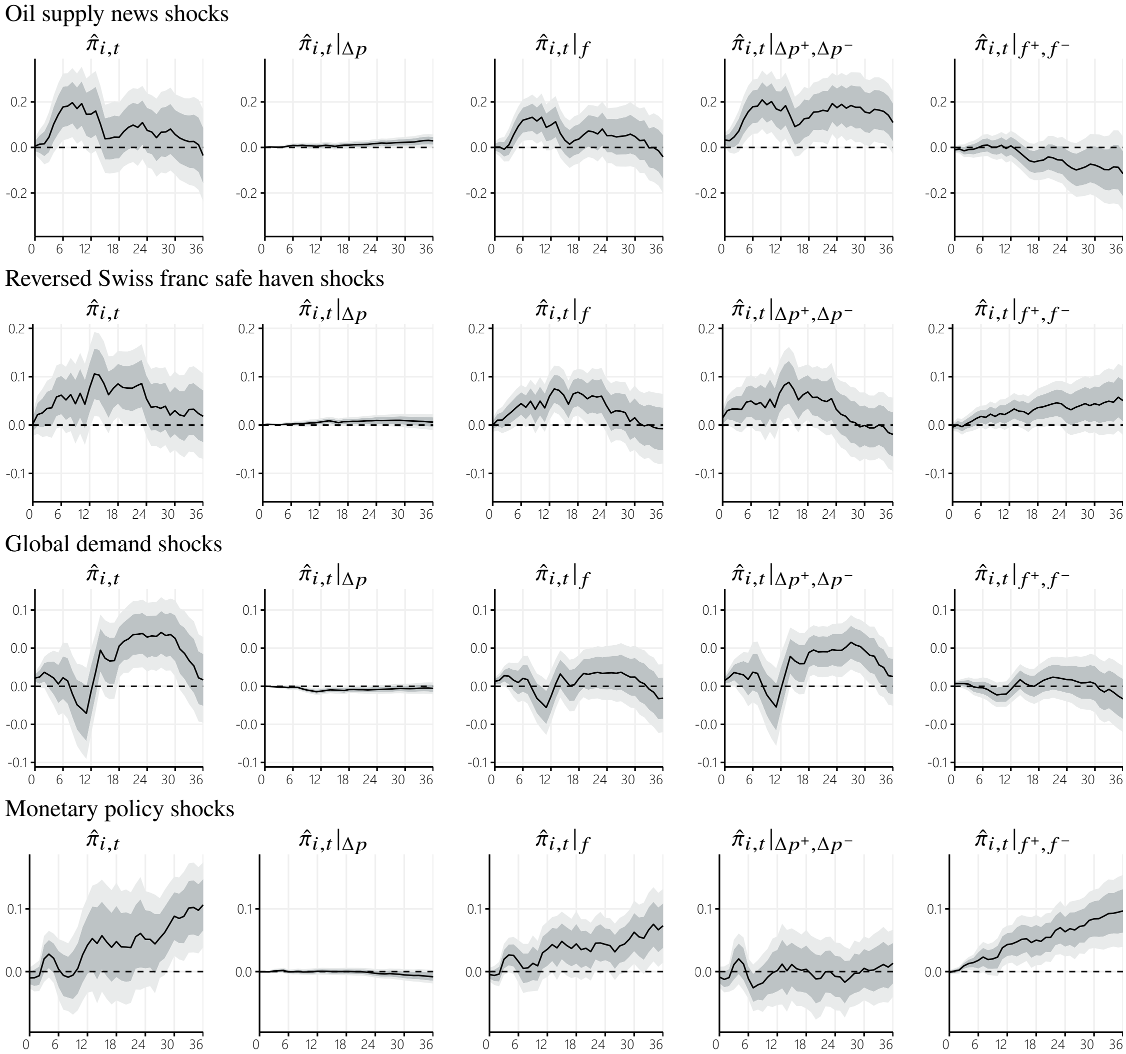
Figure E.1: Aggregate shocks used in local projections estimations



Notes: The figure shows the aggregate shocks used in the linear and nonlinear local projections estimations over the sample from 2008:01 to 2022:12.

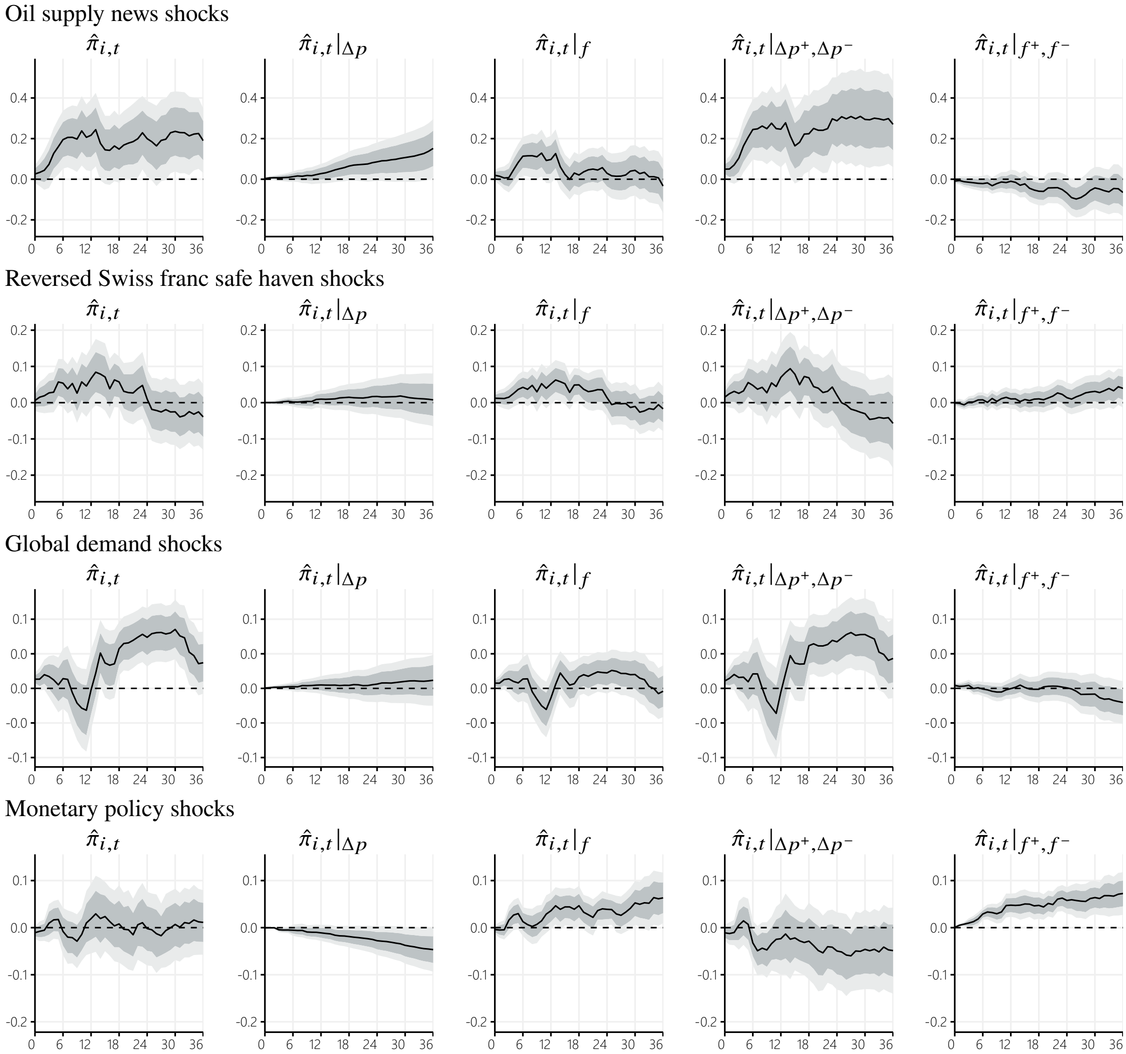
these results to the treatment of temporary sales and product substitutions. The IRFs are quite similar when price changes due to temporary sales (Figure E.2), or product substitution (Figure E.3), or both (Figure E.4) are excluded.

Figure E.2: Conditional responses of (recomposed and counterfactual) inflation rates to aggregate shocks from linear local projections, excluding price changes due to temporary sales



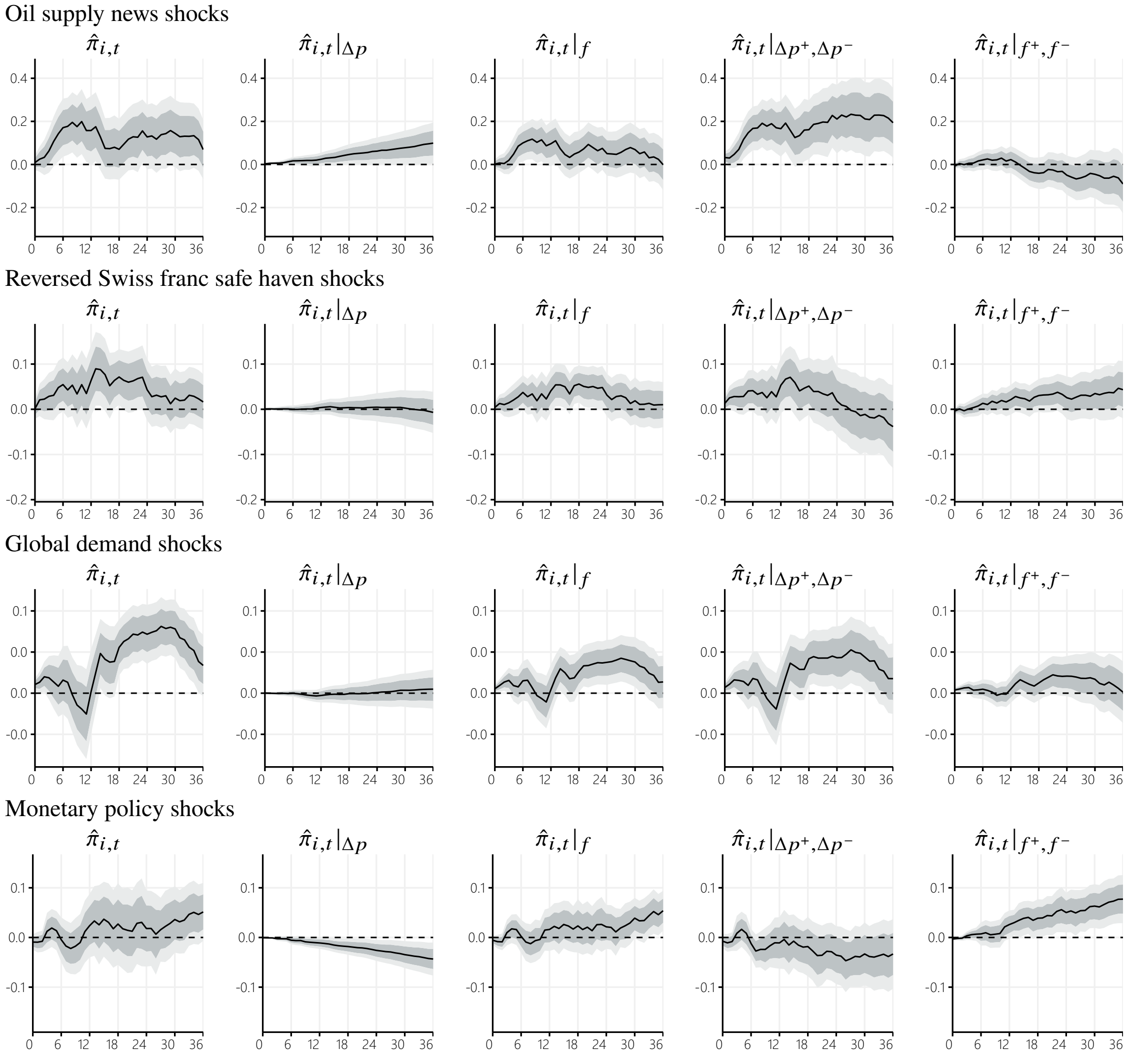
Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to aggregate shocks estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that excludes price changes due to temporary sales and includes price changes due to product substitution. The models are specified in Equation (8). The rows represent the IRFs to the different shocks: oil supply news, safe haven, global demand, and monetary policy. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

Figure E.3: Conditional responses of (recomposed and counterfactual) inflation rates to aggregate shocks from linear local projections, excluding price changes due to product substitution



Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to aggregate shocks estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and excludes price changes due to product substitution. The models are specified in Equation (8). The rows represent the IRFs to the different shocks: oil supply news, safe haven, global demand, and monetary policy. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

Figure E.4: Conditional responses of (recomposed and counterfactual) inflation rates to aggregate shocks from linear local projections, excluding price changes due to temporary sales and product substitution

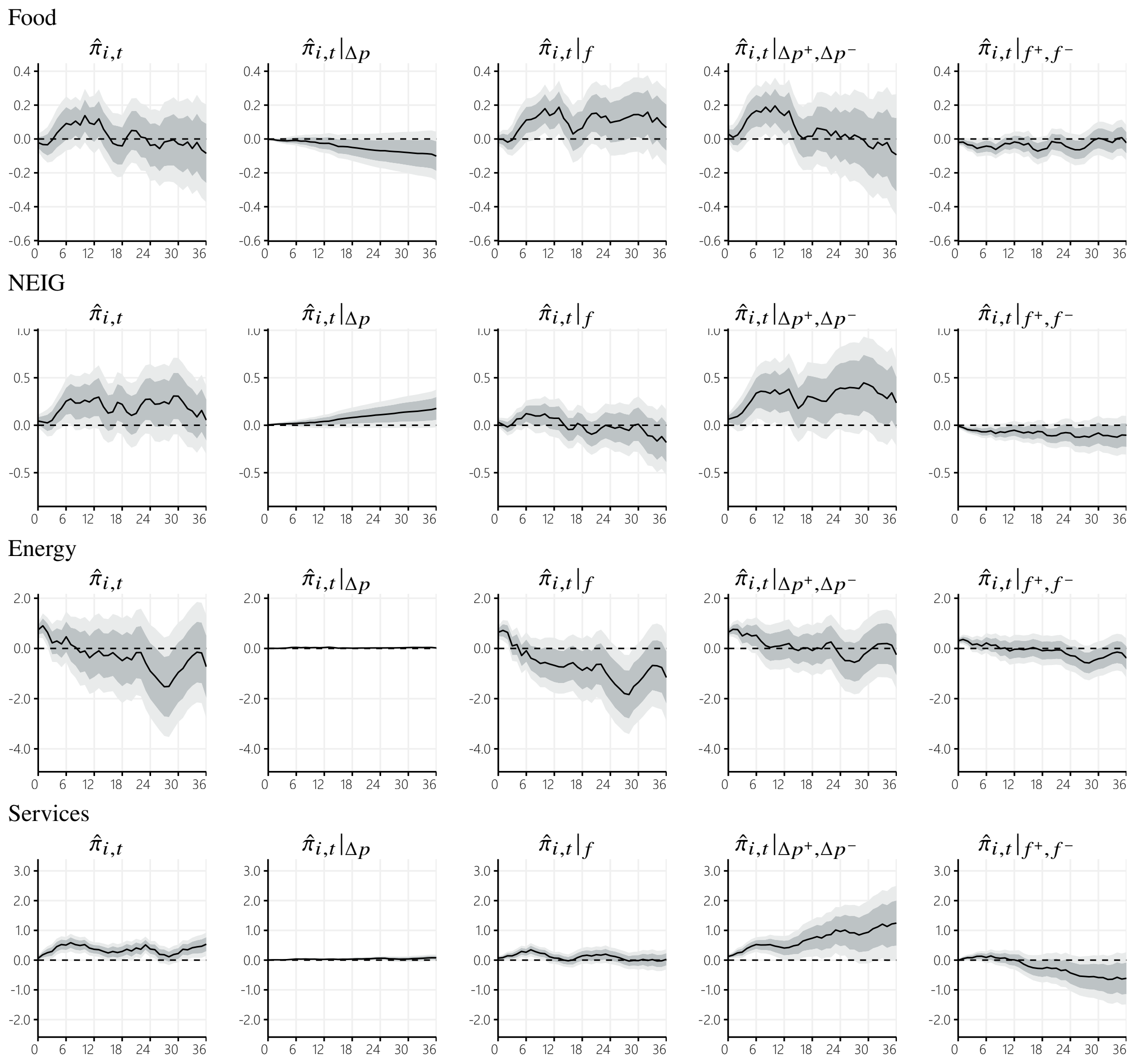


Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to aggregate shocks estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that excludes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs to the different shocks: oil supply news, safe haven, global demand, and monetary policy. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

E.3 Cross-sectional heterogeneity

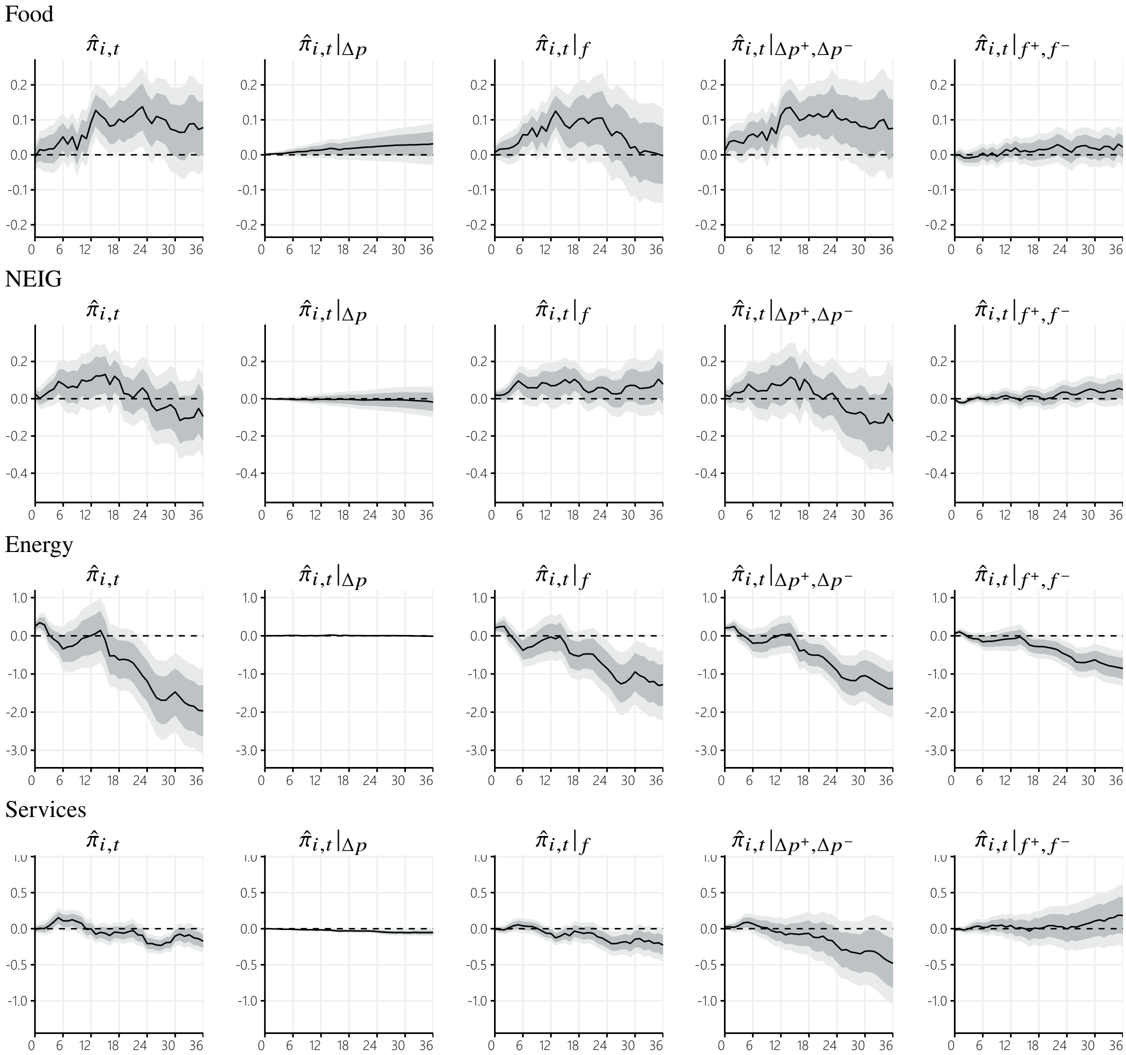
This section examines the sectoral differences in inflation responses to the aggregate shocks.

Figure E.5: Conditional responses of (recomposed and counterfactual) inflation rates to oil supply news shocks across sectors from linear local projections



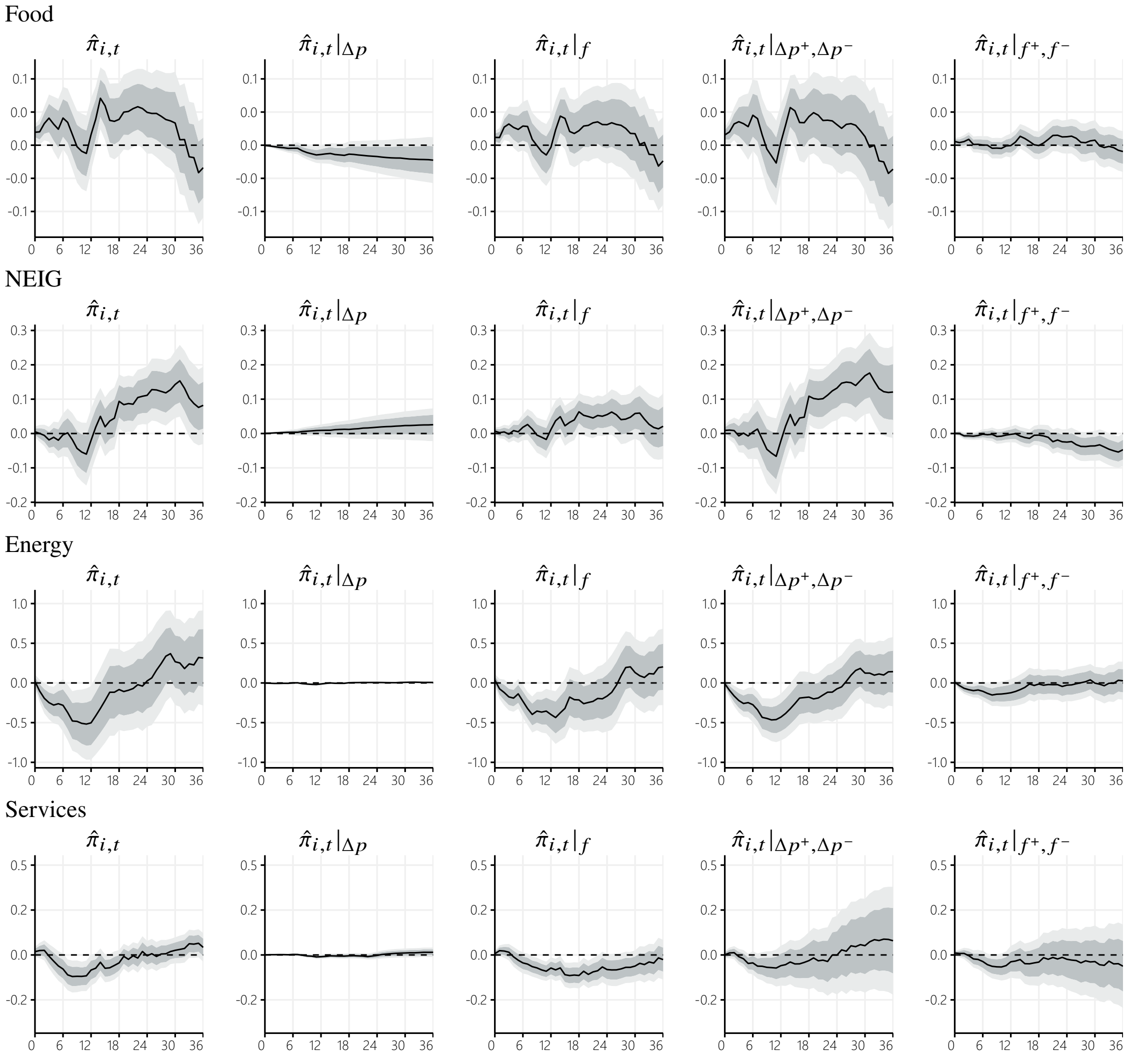
Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to oil supply news shocks across sectors estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs across sectors: food, NEIG, energy, and services. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^{+},\Delta p^{-}}$ and $\hat{\pi}_{i,t}|_{f^{+},f^{-}}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

Figure E.6: Conditional responses of (recomposed and counterfactual) inflation rates to reversed Swiss franc safe haven shocks across sectors from linear local projections



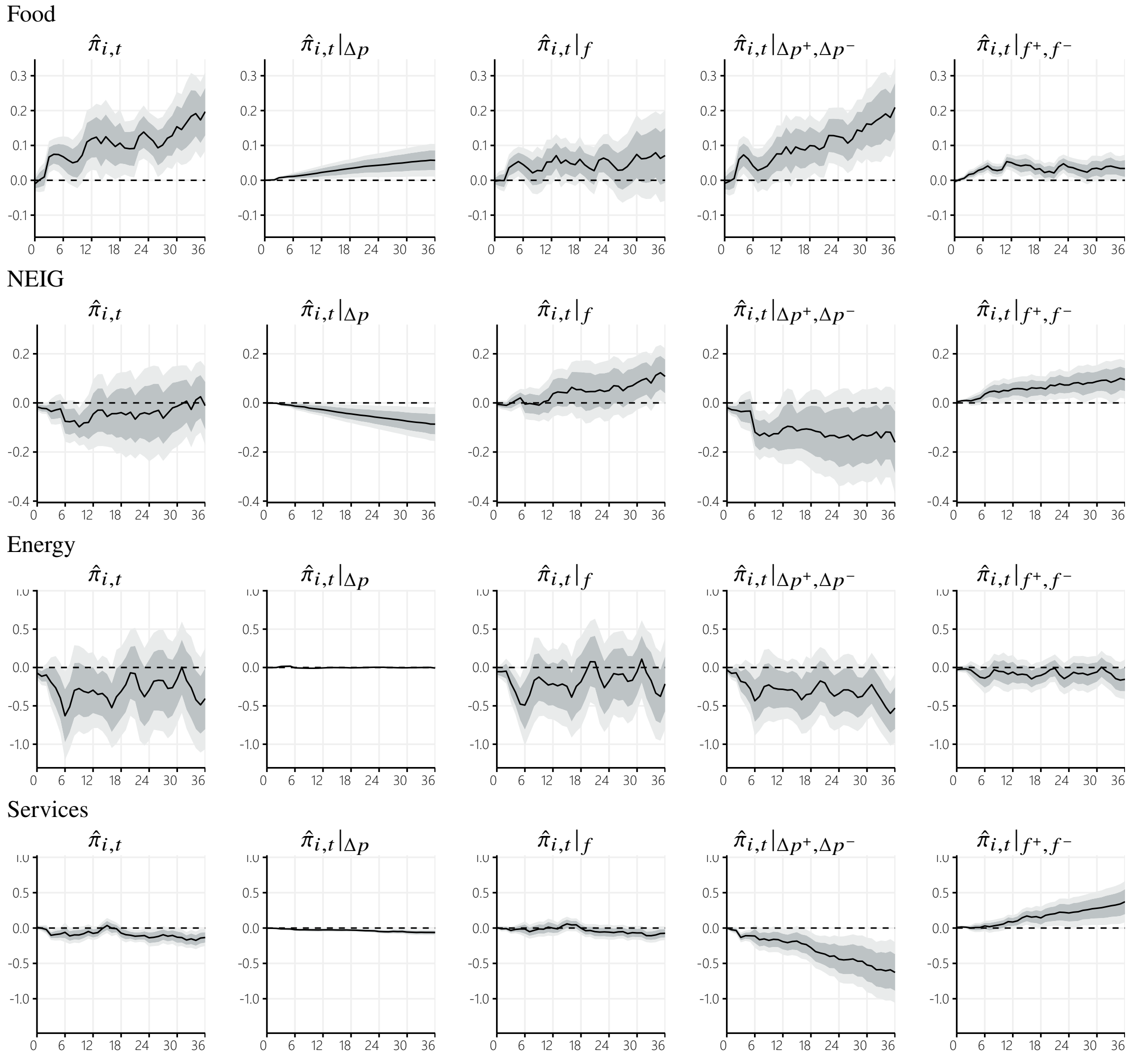
Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to reversed Swiss franc safe haven shocks across sectors estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs across sectors: food, NEIG, energy, and services. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

Figure E.7: Conditional responses of (recomposed and counterfactual) inflation rates to global demand shocks across sectors from linear local projections



Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to global demand shocks across sectors estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs across sectors: food, NEIG, energy, and services. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

Figure E.8: Conditional responses of (recomposed and counterfactual) inflation rates to monetary policy shocks across sectors from linear local projections

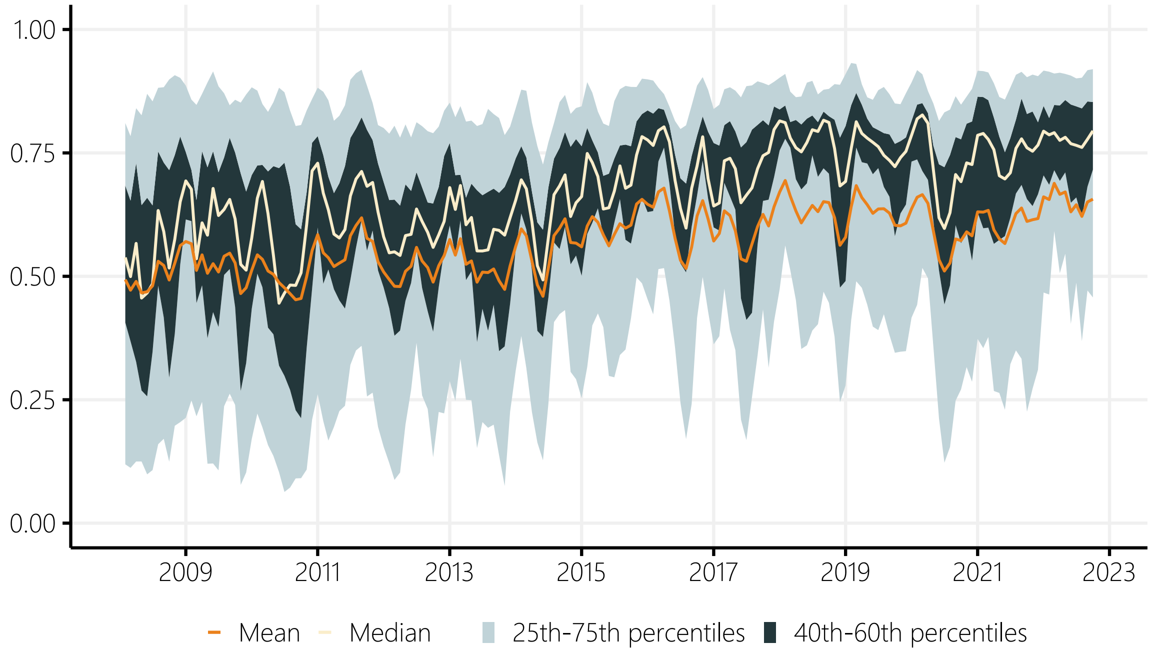


Notes: Impulse response functions (solid lines) of recomposed and counterfactual inflation rates to monetary policy shocks across sectors estimated using panel linear local projections and the sample of CPI microdata from 2008:01 to 2022:12 that includes price changes due to temporary sales and product substitution. The models are specified in Equation (8). The rows represent the IRFs across sectors: food, NEIG, energy, and services. The columns correspond to recomposed inflation ($\hat{\pi}_{i,t}$) and counterfactual inflation rates: assuming constant size and frequency of price changes ($\hat{\pi}_{i,t}|_{\Delta p}$ and $\hat{\pi}_{i,t}|_{f}$), and constant sizes and frequencies of price increases and decreases ($\hat{\pi}_{i,t}|_{\Delta p^+,\Delta p^-}$ and $\hat{\pi}_{i,t}|_{f^+,f^-}$). The dark- and light-gray areas are the 68 and 90 percent confidence bands, respectively.

E.4 State variables and resulting smooth transition functions

Figure E.9 displays the distribution of the smooth transition functions, $F(z_{i,t})$, resulting from item-level sufficient statistics as calculated in Equation (9) and aggregated across items using CPI expenditure weights.

Figure E.9: Distribution of smooth transition functions



Notes: The figure shows the distribution of the smooth transition functions, $F(z_{i,t})$, aggregated across items using CPI expenditure weights. It depicts the mean, the median, the 20th-40th percentiles range (dark-shaded area), and the interquartile range. The transition functions are the three-month centered moving average calculated over the sample from 2008:01 to 2022:12 including price changes due to temporary sales and product substitution. The parameterization of the transition functions follows the baseline specification (i.e., $\gamma = 3$).