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Tracking inflation on a daily basis

Santiago E. Alvarez¹ and Sarah M. Lein^{1,2,3*}

Abstract

Using online data for prices and real-time debit card transaction data on changes in expenditures for Switzerland allows us to track inflation on a daily basis. While the daily price index fluctuates around the official price index in normal times, it drops immediately after the lockdown related to the COVID19 pandemic. Official statistics reflect this drop only with a lag, specifically because data collection takes time and is impeded by lockdown conditions. Such daily real-time information can be useful to gauge the relative importance of demand and supply shocks and thus inform policymakers who need to determine appropriate policy measures.

Keywords: Daily price index, Scraped online price data, Debit card expenditures, Real-time information

1 Introduction

The COVID19 pandemic has led to dramatic changes in expenditures across product categories¹. Moreover, prices may reflect both negative demand and supply shocks, which have arguably affected the economy to an unprecedented degree. This makes it difficult for statistical agencies to accurately measure consumer prices in real time because expenditures are usually collected at a low frequency, and price collection is partially impossible because the retail outlets where statistical agencies usually collect prices are closed².

Additionally, policymakers must counter the crisis with the appropriate measures. These may differ depending on the relative importance of supply and demand shocks. The large decline in overall aggregate production or nominal consumption cannot inform on this because negative demand and supply shocks move quantities in the same direction. Furthermore, prices reflect these opposing forces since demand and supply shocks of the same sign push prices in opposite directions. This makes a daily

price index a useful source of information for policymakers.

In this paper, we construct a daily price index based on scraped online price data and expenditure weights based on debit card transactions by product category for Switzerland. This index allows us to monitor changes in the price level in real time and on a daily basis. We complement this index with data on the consumer price index (CPI) for categories for which we lack online prices or high-frequency changes in expenditure weights. We first show that the index is close to the official CPI before the lockdown, suggesting that we measure the same underlying dynamics. We then show that prices declined immediately after the lockdown, information that becomes available in official CPI figures only much later. Compared to the week before the lockdown, the daily price index declines by approximately 0.4% immediately after the lockdown and by approximately 0.7% until the time of this writing (the second week of July 2020). Using online prices during the lockdown can also be useful because many purchases have to be made online since retail stores are closed (for example, purchases of apparel). According to recent evidence based on point-of-sale transaction data, online retail payments related to e-commerce more than doubled during the lockdown period, compared to the same period in 2019 (Kraenzlin et al. 2020)³. Thus,

¹See, for example, Brown et al. (2020), Carvalho et al. (2020), Baker et al. (2020), Coibion et al. (2020), or Andersen et al. (2020).

²See Diewert and Fox (2020) for a detailed exposition of the problems surrounding CPI construction and data collection during the pandemic.

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³The shift towards e-commerce is also shown in the monitoring consumption data in credit card expenditures shown in Fig. 10 in Appendix 3.

with local retail stores being closed, online prices arguably reflect most of the purchases made during that period.

We show two applications for which such high-frequency data could be informative. First, we can observe both changes in quantities and prices by sector from before the lockdown to the period where many businesses were closed. Changes in prices and expenditures are very heterogeneous across sectors. We show that expenditures on food and beverages (at home) increase somewhat in total, and also prices increase. Meanwhile, prices and expenditures in categories are directly (accommodation and restaurants, entertainment, personal and professional services, other retail) and indirectly (transport) affected by the lockdown decline. Observing prices and quantities moving in the same direction suggests that, while clearly supply and demand shocks are both present, demand shocks are somewhat more prevalent at the moment, suggesting a slightly positive demand shock in the food at home category, and negative ones in the other categories named above. Using a daily price index by category allows us to monitor these sectoral developments closely, since the strength of demand and supply shocks may fade more or less quickly.

Second, we can ask whether prices are more or less flexible during and after the lockdown period?⁴ Looking at weekly frequencies of price adjustments, we do not find a significant increase or decline in the frequency of price adjustments during the lockdown period. However, when looking at the different product categories, we find a somewhat higher frequency of price increases in the food and beverages category, while price adjustment frequencies in the other sectors are either stable or decline slightly. Here, too, monitoring the frequency of price adjustment on a high-frequency and real-time basis may turn out useful in the aftermath of the lockdowns to track potential inflationary or deflationary pressures.

This paper is related to Diewert and Fox (2020), who suggest using online prices and real-time expenditure weights to construct the CPI during lockdown conditions. Our paper is an attempt to create such an index. It is also related to the literature on scraped online price data and their use in measuring the cost of living. Cavallo (2017) shows that online prices are similar to offline prices, suggesting that at least some of the prices underlying CPI calculations could be collected using scraping tools⁵. We show that replacing approximately 25% of the CPI basket with online prices results in very similar dynamics to those

of the official monthly CPI before the COVID19-related lockdown. Our paper is therefore also related to the recent studies that monitor the economic consequences of COVID19, in particular the effects on inflation⁶. Balleer et al. (2020) use a monthly business tendency survey from Germany to infer the response of the price level to the COVID19 shock using firms' responses to questions about their prices in the coming months. They find that prices tend to decline, consistent with what our index shows for Switzerland⁷.

Our work also relates to Cavallo (2020) and Seiler (2020). They show that updating the weights of the official CPI with changes in credit or debit card expenditures by product category results in higher aggregate price levels after lockdowns than those reported in official CPI figures. This is because consumers tend to switch expenditures towards product categories with relatively higher inflation rates (mostly food and beverages). Consistent with their findings, our price level is also higher when using CPI prices and debit-card expenditure adjusted weights and prices from the official CPI. Our main contribution in this paper is that we also use online prices, in addition to these adjusted expenditure weights. This allows us to track, in addition to changes in expenditure weights, also daily changes in prices. Because online prices during the lockdown declined somewhat more than official CPI prices, we observe overall a decline in the aggregate price level in our index.

Furthermore, our results on sectoral heterogeneity in responses of prices and quantities are related to Baqaee and Farhi (2020) and Guerrieri et al. (2020). Both show that differences across sectors are important to understand the propagation of (sectoral) supply and demand shocks. Monitoring both changes in quantities and prices for different product categories (or sectors) can thus be informative for the debate over whether the COVID19 shock is more of a supply or demand shock (see, for example, Baldwin and Weder di Mauro (2020), Balleer et al. (2020), and Brinca et al. (2020)).

This paper is structured as follows. In Section 2, we describe the online price data and the construction of price indexes. In Section 3, we report the price indexes up to the most recent data point as of this writing. We also discuss potential biases in official statistics during the lockdown. Section 4 documents the frequency of price adjustments in the aggregate and by category. Section 5 draws some conclusions.

⁴This question is related to the empirical literature on state- versus time-dependent pricing. One of the main findings in this literature is that the frequency of price adjustment looks very stable in periods where aggregate shocks are not very large on average, but the frequency of price adjustment can vary a lot when shocks are large, as shown for example in Gagnon (2009), Karadi and Reiff (2010), and Auer et al. (2018).

⁵See also Cavallo and Rigobon (2016) and Cavallo et al. (2018).

⁶For daily indicators of economic activity, see, for example, Burri and Kaufmann (2020), Eckert and Mikosch (2020), Eichenauer et al. (2020), or Lengwiler (2020).

⁷Overall, recent research suggests that price responses differ across sectors. Burghof et al. (2020) collect online prices for five supermarkets in Germany. They find a slight increase in these prices of approximately 0.8% between February and April.

2 Data and methodology

Data for prices have been scraped from various websites on a daily basis since May 2018 for supermarket goods and since May 2019 for other categories, such as clothing, electronics, furniture, and heating oil. See Alvarez (2020) for a more detailed description. In this study, we focus on the data starting in May 2019 because we have a broader set of goods in the database. The data were extracted from six online retailers selling in the categories “Food, alcohol, and tobacco,” “Clothing and footwear,” “Heating oil,” “Furniture,” “Electronics,” “Office material,” and other supermarket items⁸. The majority of these retailers also have physical stores across Switzerland. These data allow us to identify products uniquely over time using shop-specific identifiers.

Table 1 provides an overview of the data and compares it to the official Swiss Federal Statistical Office (SFSO) main categories. Some of the categories are covered entirely by online prices such as “Food and non-alcoholic beverages” or “Clothing and footwear.” For some categories, such as “Housing and energy,” the substitution of official (SFSO) prices can be performed at lower levels of the CPI. Thus, online prices do not cover the entire main category weight (see Table 3 in Appendix 1 for a detailed overview of the replaced categories at different levels of aggregation). As services account for approximately 60% of the CPI basket weight, we are able to update the index with daily online data representing more than half of the weight for goods. The total number of products used for this analysis is 75,311⁹.

To construct representative consumption baskets, we use the product category weights provided by the SFSO. Beginning in January 2020, we update these weights to reflect changes in consumption patterns before, during, and after the lockdown, as suggested in Cavallo (2020) and applied for the Swiss CPI in Seiler (2020). Daily real-time data for quantities per product category are taken from daily debit card expenditures published by the Monitoring Consumption Initiative for Switzerland¹⁰. We sum expenditures by category and week over regions (Grossregion). We sum the three categories “Motor and Vehicles,” “Fuel,” and “Transport,” because they are all included in the CPI category (“Transport”). We use weekly data because the

daily data are noisier due to day-of-the-week effects (very small numbers of transactions on Sundays). We show the expenditure data by category relative to the week before the first lockdown phase that began on March 16, 2020, in Fig. 1¹¹.

These shifts in consumption expenditures are then reflected in changes in CPI category weights during the lockdown. For example, the weight of the category “Food and non-alcoholic beverages” increases by almost 50% from 10.5 to 15.5% (Table 1, comparing the third with the fifth column). Meanwhile, the weight of “Restaurants and hotels” declines from 9.5 to only 1.2%. Related to these expenditure shifts, relative expenditures on categories, where nominal expenditures remain mostly constant, go up. “Housing and energy,” for example, includes rents (a weight of 24.3% in the total CPI), which probably do not change much during the lockdown. Since aggregate expenditures on the debit card categories decline by up to 25% (Fig. 1), the relative weight on rents increases to 35%. Rents are arguably not paid with debit cards, but via regular bank account transactions¹².

One caveat of the debit card expenditure data is that it includes only debit cards and not credit cards. Arguably, online spending is mostly done via credit card transactions. This online spending is thus probably not included in our weights and may overstate the decline in retail products that were not available in closed stores, but still available online¹³. Our main price index, as we describe below, is an average of an index that fully reflects these expenditure shifts (Paasche) and an index that does not reflect these shifts (Laspeyres). This potential overstated decline is therefore muted in our main price index (Fisher).

To compute the price index on a daily basis, we proceed in two steps. First, we use the CPI weights, which do not reflect changes in consumption due to the lockdown. We replace prices in the CPI with daily online prices for all categories with online prices, as shown in Table 1. For each category $j = 1 \dots J$, we construct a category-level Jevons index over the set of $i = 1 \dots N$ products observed in the base period, which is the week before the lockdown (9 March 2020 to 15 March 2020) as:

⁸These retailers are Interdiscount, Mediamarkt, Coop, Ikea, Zalando, and Heizol.ch. We selected these retailers because the format of their website was suited for scraping and they are representative online and offline stores for several components of the CPI. These stores tend to be large retailers, but of course they represent only a share of all online purchases. For example, rather upscale stores are not included. We plan to add more such stores in the future.

⁹Note that these can be a given good but identified at two different retailers (e.g., one specific PC that is sold by two different retailers) or in the case of heating oil the same good sold across different locations.

¹⁰See <http://monitoringconsumption.org/switzerland>, which is a joint initiative of the University of St. Gallen, the University of Lausanne, and Novalytica. The data are publicly available. They contain similar information to, for example, the OpportunityInsights data for the USA described in Chetty et al. (2020) and used in Cavallo (2020).

¹¹Switzerland had strict restrictions in place from March 16 to April 26 and opened lower-risk businesses and retail stepwise between April 27 and June 15, with openings of hairdressers, cosmetic studios, do-it-yourself stores, flower shops, and garden centers in the first step, and shops, restaurants, markets, museums, and libraries in the second step (as of May 11).

¹²The decline of approximately 25% is also consistent with aggregate debit and credit card data shown in Fig. 10 in Appendix 3. Since credit card transactions are not available as a breakdown into merchant categories, we cannot use them to infer the expenditure weights, but the total spending pattern is consistent with the one based on debit cards only.

¹³In Fig. 10, we show that total expenditures on credit cards and debit cards display similar dynamics, where online expenditures with credit cards seem to just offset the larger decline in credit card point-of-sale transactions (compared to debit card point-of-sale transactions), such that the total credit card and debit card spending shows similar dynamics as debit card spending alone.

Table 1 Used CPI basket and weights

| Name | Source | | Weight | | | Prod. |
|----------------------------------|---------|-------------|--------|--------|----------|--------|
| | Prices | Weight | SFSO | Online | Lockdown | |
| Food and non-alcoholic beverages | Online | Debit card | 10.54 | 10.54 | 14.93 | 8221 |
| Alcoholic beverages | Online | Debit card | 2.76 | 2.76 | 3.91 | 351 |
| Clothing and footwear | Online | Debit card | 3.4 | 3.4 | .91 | 26,223 |
| Housing and energy | Online* | SFSO | 24.96 | .69 | 33.14 | 9 |
| Household goods and services | Online* | SFSO | 3.79 | 3.35 | 5.03 | 13,679 |
| Healthcare | Online* | SFSO | 15.69 | .21 | 20.83 | 47 |
| Transport | SFSO | Debit card | 10.97 | 0 | 8.08 | 0 |
| Communications | Online* | SFSO | 2.94 | .17 | 3.91 | 691 |
| Recreation and culture | Online* | Debit card | 8.37 | 2.12 | 4.509 | 22,778 |
| Education | SFSO | SFSO | 1 | 0 | 1.32 | 0 |
| Restaurants and hotels | SFSO | Debit card | 9.46 | 0 | 1.17 | 0 |
| Other goods and services | Online* | Debit card | 6.12 | 1.59 | 1.92 | 3312 |
| Total | Online* | Debit card* | 100 | 24.502 | 100 | 75,311 |

Categories in which source contains an asterisk symbol (*) are categories in which part of their weight was substituted either with online data or with debit card data, but at lower levels of the CPI basket (see Table 3 in Appendix 1 for the exact matching). SFSO weights are the official CPI basket weights, online weights indicate the part out of the official weights covered by online prices, and lockdown weights are weights for the first week after the lockdown adjusted using credit card transaction data

$$P_j^t = \prod_{i=1}^N \left(\frac{P_i^t}{P_i^0} \right)^{\frac{1}{n}} \tag{1}$$

We construct a daily version of a Laspeyres (1871) price index:

$$P_{Las}^t = \sum_{i=1}^J \frac{P_j^t}{P_j^0} w_j^{0,CPI} \tag{2}$$

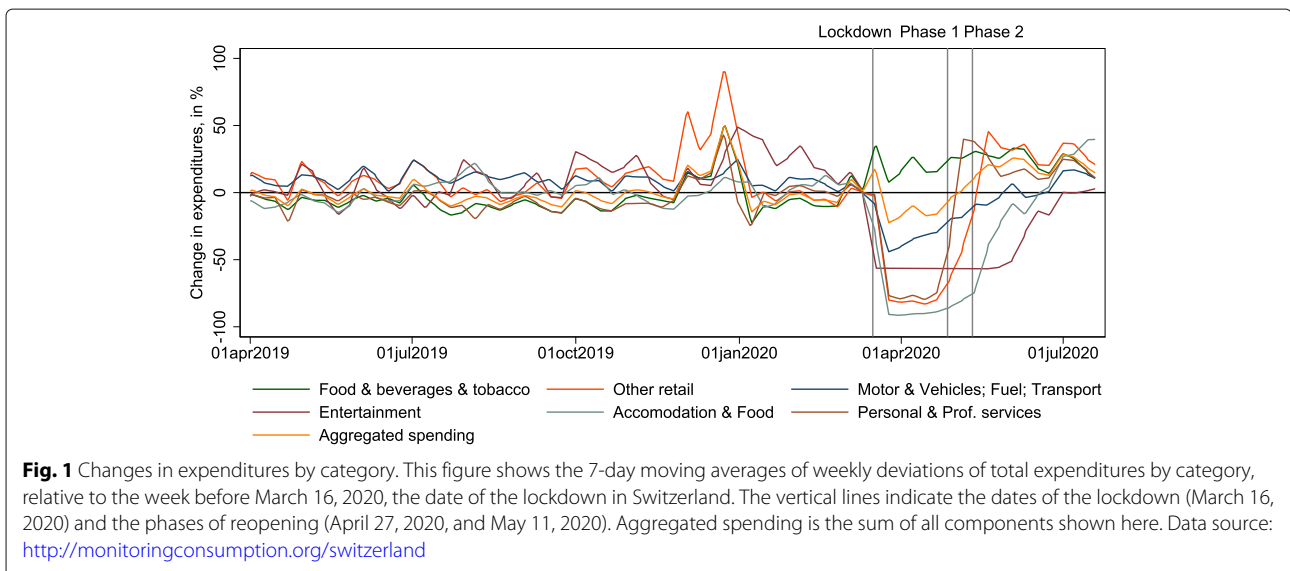
where P_j^t equals the price index for online goods in Eq. 1 or the CPI category price index from the SFSO where online prices are not available. The weight w_j^{CPI} is from the CPI

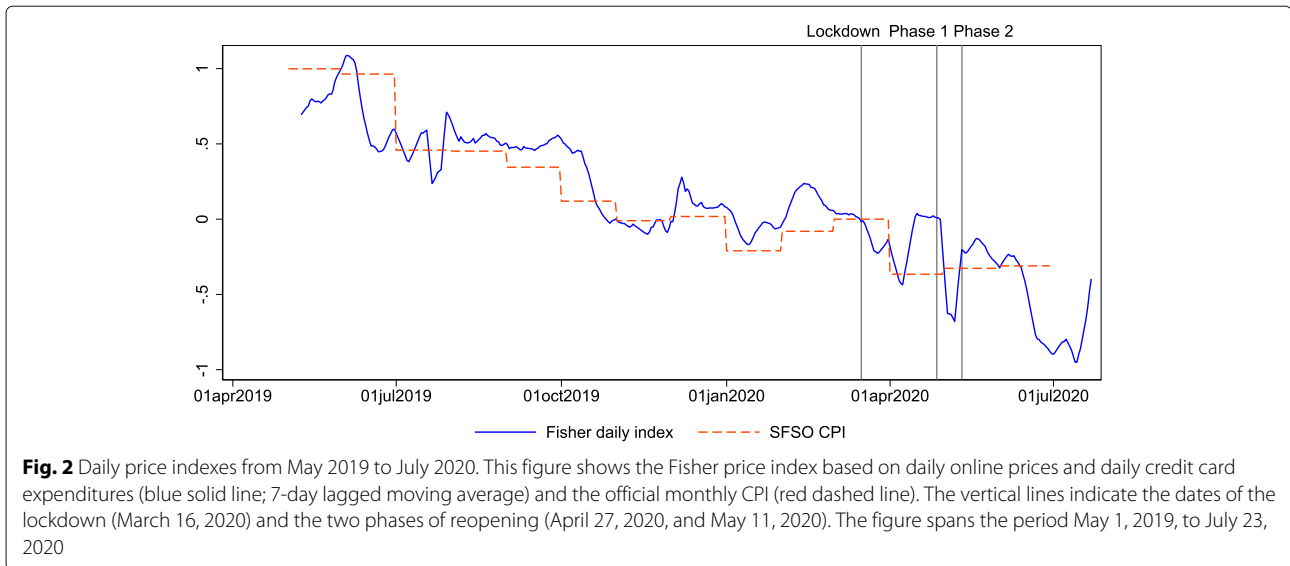
and thus does not reflect contemporaneous changes in consumption patterns due to the pandemic.

We then construct a daily version of a Paasche (1874) price index:

$$P_{Paa}^t = \left[\sum_{i=1}^J \left(\frac{P_j^t}{P_j^0} \right)^{-1} w_j^{t,COVID19} \right]^{-1} \tag{3}$$

where we include the COVID19-adjusted current-day weights and measure the price of the COVID19 basket at prices in the base period.





As is well known, the Laspeyres (Paasche) index tends to be upward (downward) biased in normal periods because consumers substitute towards products that become relatively cheaper. This means that the Laspeyres index tends to underweight the products that become cheaper, while the Paasche index overweights them. However, during the lockdown period, consumers substantially shift expenditures towards food at home and away from categories that are produced by sectors that are temporarily shut down. This substitution is not a result of relative price shifts but of many products not being available.

The Fisher index, calculated as the geometric average of the Paasche and Laspeyres indexes, should be unbiased in normal periods because it averages out the upward and downward biases of the Laspeyres and Paasche indexes, respectively. The index is thus:

$$P_t^{Fis} = (P_t^{Paa} \cdot P_t^{Las})^{0.5}, \tag{4}$$

which we use as our main index reflecting changes in both expenditures and prices.

3 Daily price indexes before, during, and after the lockdown

This section first shows how the daily Fisher price index compares to the official monthly CPI when considering a longer horizon. It then shows the lockdown period in particular and discusses biases arising from large shifts in consumption patterns.

Can online prices track official statistics at all? Figure 2 plots the 7-day moving average of the daily price index (in logs) together with the official CPI statistics since mid-2019. The longer history of this daily price index shows that it fluctuates around the official index in 2019, even though it includes only online prices for approximately

25% of the total sample. This is consistent with the results in Cavallo (2017) that online and offline prices are similar in normal times and that online prices can be used as inputs for CPI calculations instead of offline prices. While Fig. 2 includes the CPI prices for categories, for which we do not have online prices, the similarity is not only driven by these categories. Figure 7 in Appendix 1 shows the comparison of online prices with those of the CPI only for the categories where we could replace CPI prices with online prices. The dynamics are similar.

Figure 3 shows daily price indexes in 2020. The beginning of the lockdown is shown as a vertical line on March 16, and the beginning of the two reopening phases is shown for April 27 and May 11 (see also footnote 11). In the upper panel, we show the Fisher daily index and the official CPI around the lockdown and the reopening phases. The Fisher index shows that immediately after the lockdown, prices declined by approximately 0.4%. This information is available approximately 6 weeks earlier than the official index, which is released in early April for data collected for the month of March. The online index declines by a similar amount as the official index, after it has been updated with the prices that could be collected at the time¹⁴. At the time of writing, the price index is around 0.5% below the pre-lockdown level¹⁵. This suggests that, in the very short run, negative demand shocks dominate negative supply shocks, consistent with findings for Germany based on producer surveys (Balleer et al. 2020).

¹⁴According to press releases from the SFSO, approximately 20% of all prices could not be collected in April. This share increases to 25% for the sectors most affected by the pandemic.

¹⁵The large swing in June is mostly due to the category “clothing,” where we had observed a large share of seasonal sales.

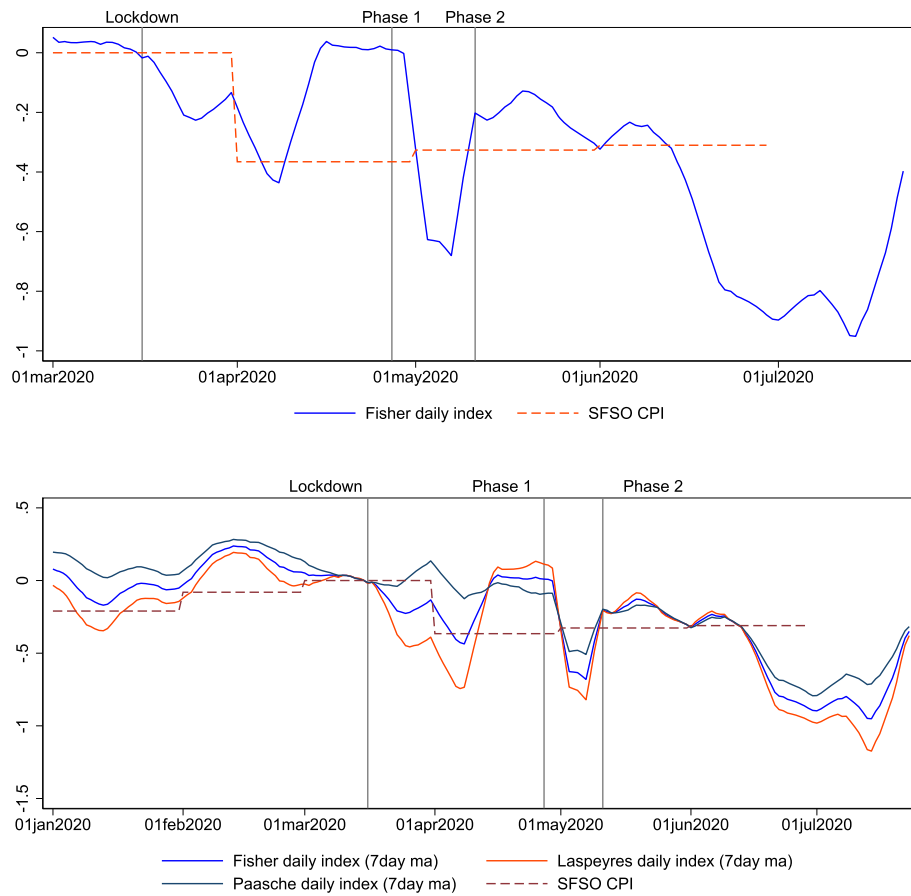


Fig. 3 Daily price indexes in 2020. The upper panel in this figure shows the Fisher price index based on daily online prices and daily credit card expenditures (blue solid line; 7-day lagged moving average) and the official monthly CPI (red dashed line) around the lockdown and reopening period. The lower panel shows the Fisher (blue), Laspeyres (red), and Paasche (gray) indexes during the lockdown and reopening periods together with the official monthly CPI (red dashed line). The vertical lines indicate the dates of the lockdown (March 16, 2020) and the two phases of reopening (April 27, 2020, and May 11, 2020). The figure spans the period May 1, 2019, to July 23, 2020

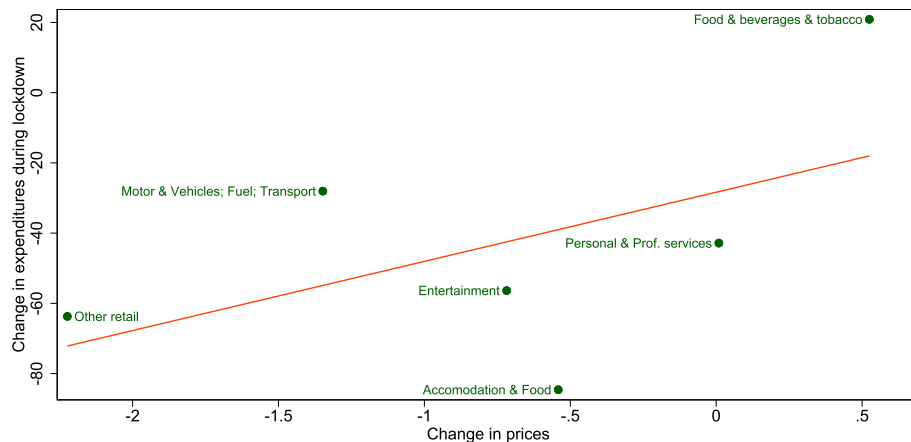
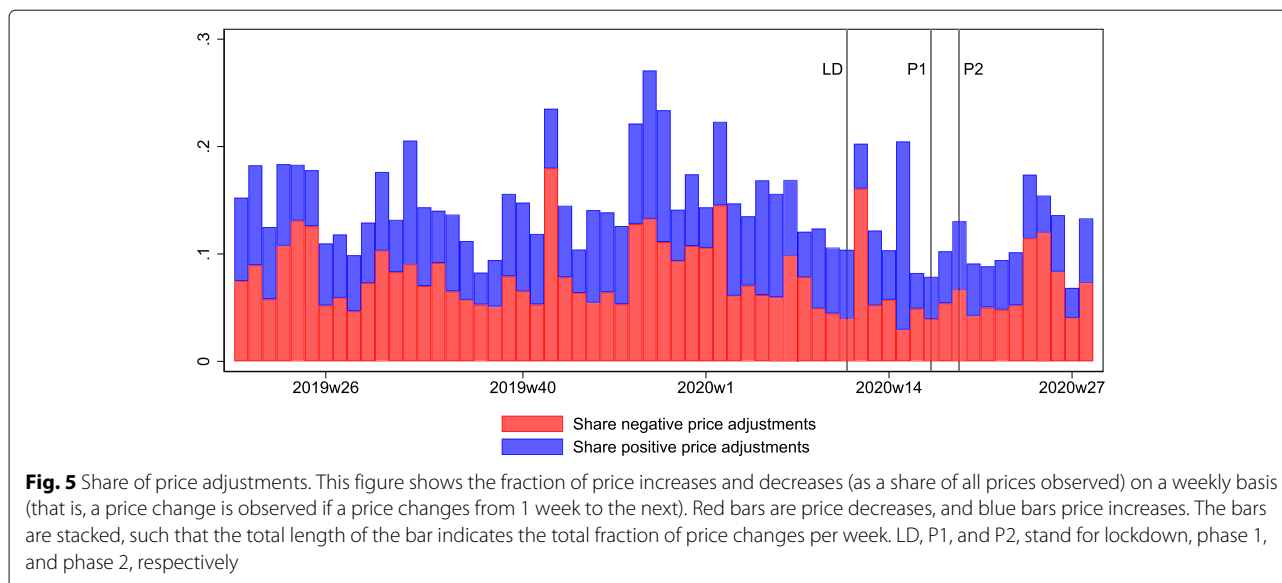


Fig. 4 Relationship between the change in prices and change in expenditures during the lockdown. This figure shows a scatter plot of the change in average expenditures and average change in prices during the lockdown period from March 16, 2020, to May 11, 2020



The bottom panel of Fig. 3 shows the three daily price indexes: Paasche, Laspyres, and Fisher. The difference between the Laspyres and Fisher indexes illustrates the extent of substitution bias. It is larger in the period after the lockdown, which reflects the large shifts in spending patterns depicted in Fig. 3. The bias amounts to up to 0.3 percentage points, which is approximately three times larger than the substitution bias estimated before the pandemic¹⁶. In normal times, the Laspyres index tends to overestimate inflation because consumers substitute towards products that become relatively cheaper. In this case, we observe the opposite: consumers substitute towards product categories where prices were more or less stable (mostly food, beverages, and tobacco), while expenditures on product categories with falling prices decrease substantially. This is also reflected in the Paasche index, which is nearly stable (see Fig. 3, lower panel). This suggests that consumers substitute away from product categories that become relatively cheaper. This is because consumers cannot demand many of the goods from these categories due to lockdown restrictions or because tastes shift away from these goods. However, the bias is relatively short lived and becomes small again after the end of the lockdowns.

Shifts in prices and expenditures can also be compared across product categories, as it is very likely that some were affected more severely by demand shocks, while others were affected more by supply shocks (Baqae and Farhi 2020). In general, prices and quantities tend to move in the same direction in the case of demand shocks, while they move in opposite directions in the case of supply shocks. Observing both changes in quantities and prices is thus interesting regarding the debate over whether the

COVID19 shock is more of a supply or demand shock and how that differs across sectors.

Figure 4 plots the changes in prices and associated changes in spending. It shows that the price decline was particularly strong in the retail sector (excluding “Food, beverages, and tobacco”), which also shows a relatively large decline in expenditures (approx. -50%). Similar movements, albeit less pronounced, can be seen in the sector “Transport.” These falling prices and even greater reductions in expenditure are typically accompanied by a negative demand shock. Consumer spending falls most sharply in the “Hotels and restaurants” and “Leisure and culture” sectors, which were not allowed to open or only partially open. Here, too, prices fall slightly, albeit less sharply than in the sectors mentioned above. Expenditures also fall in the “Services” sector, with prices remaining almost unchanged. This would indicate that here, the demand and supply shocks are roughly balanced. In the “Food, beverages, and tobacco” sector, which was not affected by the lockdown, spending actually increased while prices remained stable. This would indicate an approximately balanced expansion of demand and supply in this sector. This is consistent with anecdotal evidence that, although initial demand in supermarkets soared just before and after the lockdown due to stockpiling motives, supply was generally not constrained¹⁷.

¹⁶This is also consistent with Diewert et al. (2009), who report a substitution bias of 0.13% for the Swiss CPI for the period 1993–2002

¹⁷One caveat in this analysis is that we use only prices that are available already before the lockdown to calculate price changes. An ideal price index that would measure the changes in cost of living from a welfare perspective would include a term adjusting for changes in variety, since some products may not be available during the lockdown, and possibly a term that adjusts for taste shifts during the lockdown. Such an index would be the one proposed by Redding and Weinstein (2019), for example, applied for the pre-lockdown period to Swiss data in Braun and Lein (2019). Since we do not observe product-specific expenditure shifts, it would be difficult to construct such an index without stronger assumptions about within-product category expenditure shifts. Furthermore, we would like to remain close to the official methodology to calculate prices, which is a Laspyres-type index.

Table 2 Averages of weekly shares of price adjustments by period

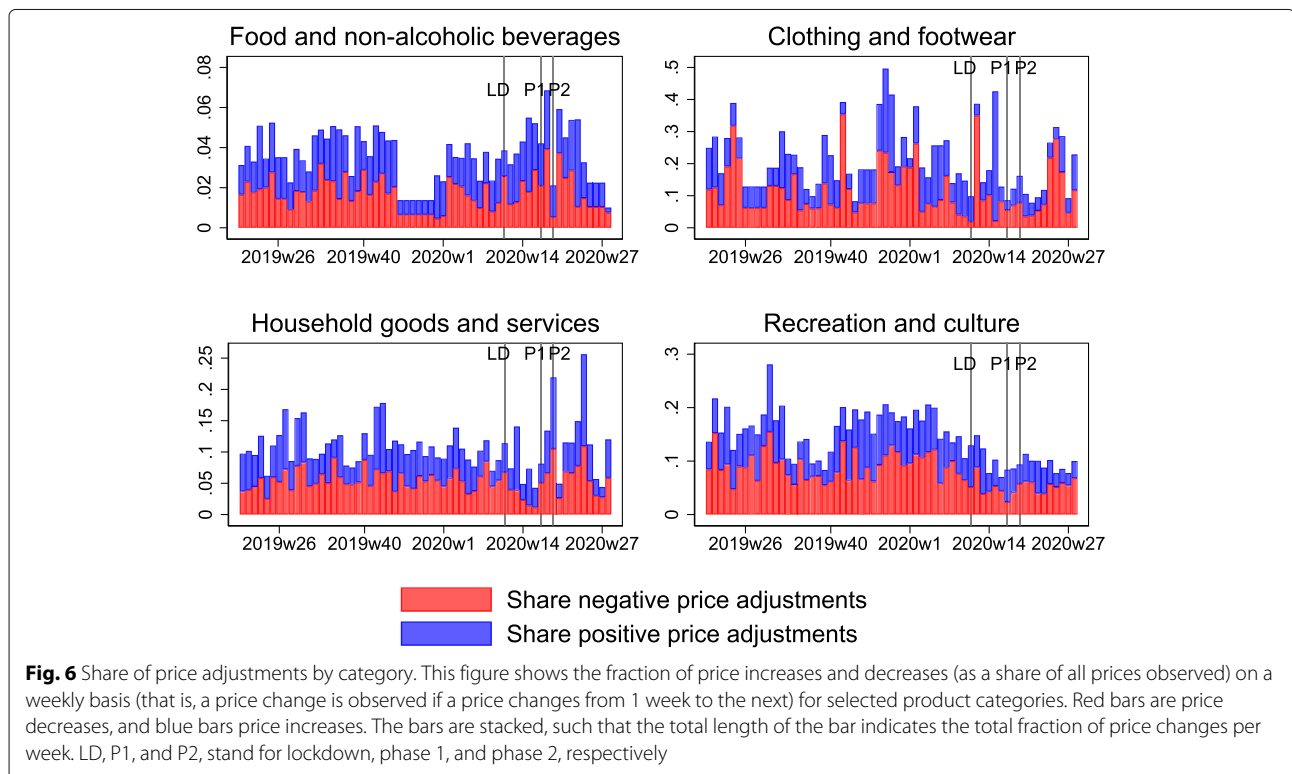
| Category | Period | | | |
|----------------------------------|-----------|-------|-------|----------|
| | Before LD | LD-P1 | P1-P2 | After P2 |
| Food and non-alcoholic beverages | .0354 | .0429 | .0553 | .0344 |
| Clothing and footwear | .2181 | .2268 | .104 | .1745 |
| Household goods and services | .106 | .0823 | .1077 | .1238 |
| Recreation and culture | .1555 | .1087 | .0851 | .0939 |
| All products | .1412 | .1128 | .0907 | .116 |

Notes: This table shows the average share of price adjustments by product category and in total during all weeks by period. LD, P1, P2, stand for lockdown (3/16/2020), phase 1 (4/27/2020) and phase 2 (5/11/2020), respectively. For example, in the product category food and non-alcoholic beverages, the weekly share of price changes is computed for each week and then we measure the average of all weeks before the LD and report it in the first column. Total includes all observed products, not only the products of the four categories displayed

4 Price setting behavior before, during, and after the lockdown

How flexibly do prices respond to the lockdown? For answering this question, we first show the share of all included products that adjust their prices on a weekly basis (see Fig. 5, which plots the frequency of positive and negative price changes in stacked bars). There is no significant change in the frequency of price adjustments when looking at all categories together. This, however, might be caused by different changes on pricing behavior by categories of goods. Furthermore, there is no clear change in the frequency of positive or negative price changes.

Table 2 shows the average share of price adjustments across the weeks included in each time interval for the four categories “Food and non-alcoholic beverages,” “Clothing and footwear,” “Household goods and services,” and “Recreation and culture.” Similar to the heterogeneity in price and expenditure changes across categories reported above, there are some differences across categories in the frequency of price adjustments. While price adjustments in “Food and non-alcoholic beverages” become somewhat more prevalent during the two phases of the lockdown (first row in Table 2 and upper left panel in Fig. 6), the price adjustments in the category “Recreation and culture” become less frequent



(fourth row in Table 2 and lower right panel in Fig. 6). Prices change less frequently during the lockdown in the category “Household goods and services,” but more frequently after the lockdown, and with more positive price adjustments (third row in Table 2 and lower left panel in Fig. 6). The frequency of price adjustment in the category “Clothing and footwear” is somewhat lower on average (second row in Table 2 and upper right panel in Fig. 6) between phases 1 and 2, but it is very volatile overall with weeks that show up to 50% of all prices changing (the scales across categories differ in Fig. 6). This is likely due to frequent sales in this category¹⁸.

Sizes of price adjustments are similar before, during, and after the lockdown, as reported in Appendix 2.

5 Conclusion

In this note, we propose a daily price index composed of daily scraped online prices for different product categories and debit card expenditures by product category. We update prices and weights of CPI categories for which we have this additional high-frequency information.

We show that the index reflects the official monthly CPI quite well in the period before the lockdown, thus confirming that online prices carry similar information as the prices that are included in the CPI. The index shows that prices decline immediately after the lockdown and remain approximately 0.4% lower than those in the week just before the lockdown was implemented, supporting recent evidence suggesting that negative demand shocks are somewhat larger than negative supply shocks. This is also the case for most product categories, where prices and expenditures both fell and thus suggest that demand shocks dominated at this point in time.

While our index can be useful for policymakers to track inflation in real time, we do not make any statements about the longer-term effects of the pandemic recession on inflation. However, since prices that consumers observe in their daily lives are an important ingredient of consumers’ inflation expectation formation process (D’Acunto et al. 2019), the daily inflation figures may carry some information about longer-term inflation expectations, which will be an important factor in determining inflation in the medium run.

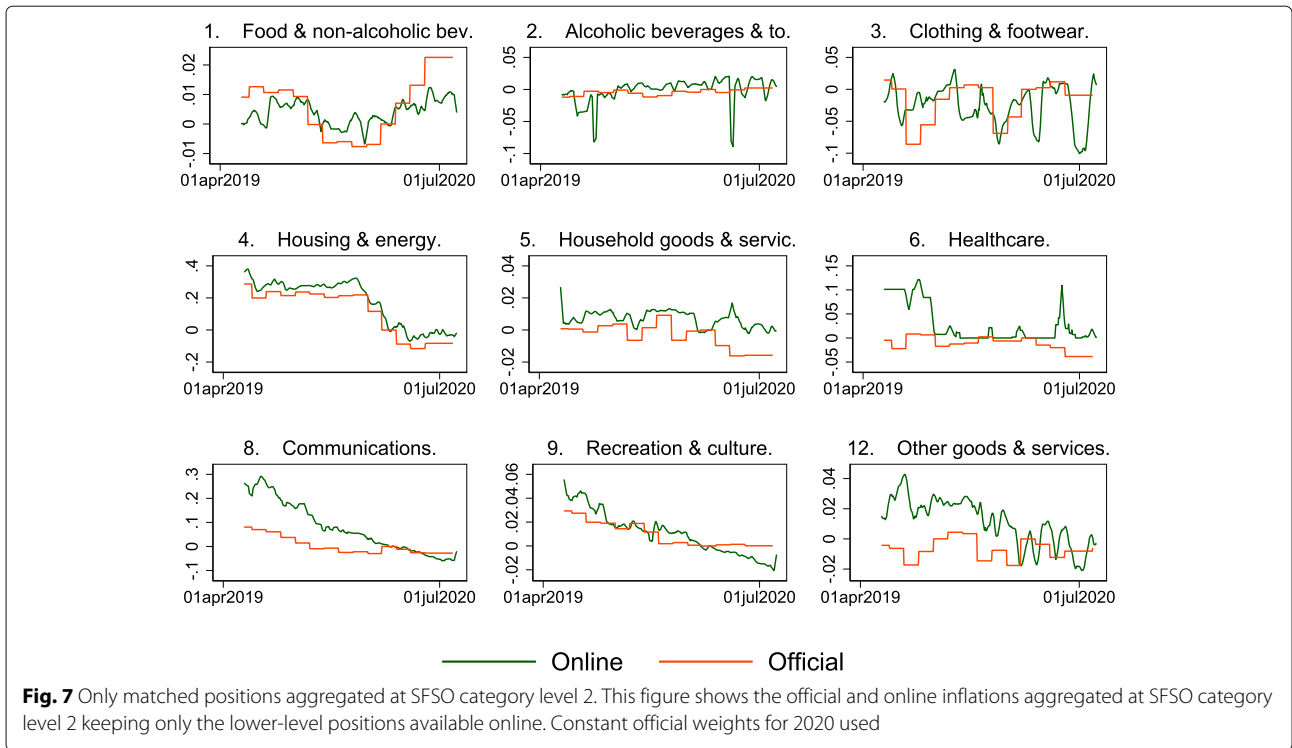
Appendix 1. Product categories with online prices

Table 3 Matched CPI categories

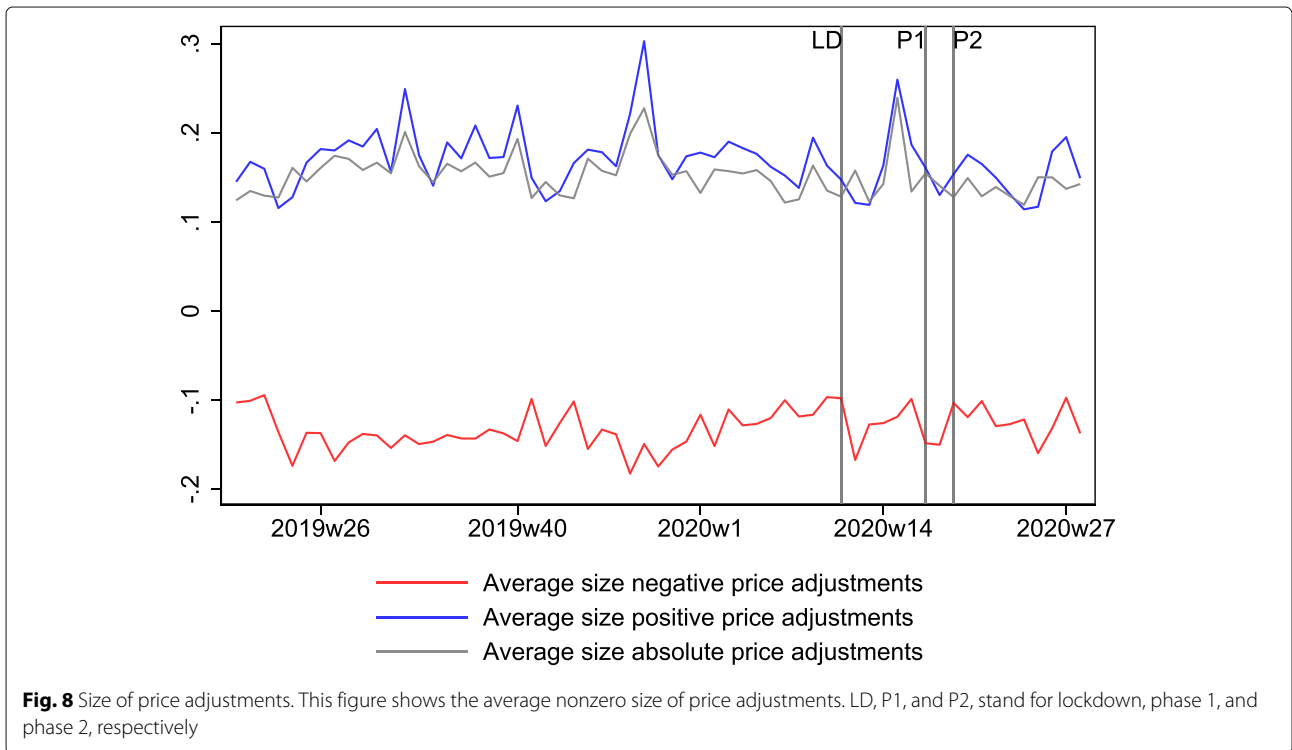
| Level 2 ID | ID | Name | Level | Weight | Products |
|------------|-------|---|-------|--------|----------|
| 1 | 1002 | Bread, flour, and cereal products | 4 | 1.6 | 1554 |
| 1 | 1074 | Meat, cold cuts, and sausages | 4 | 2.28 | 701 |
| 1 | 1179 | Fish and seafood | 4 | .37 | 257 |
| 1 | 1198 | Milk, cheese, and eggs | 4 | 1.6 | 1155 |
| 1 | 1284 | Fats and edible oils | 4 | .26 | 143 |
| 1 | 1305 | Fruit, vegetables, potatoes, and mushrooms | 4 | 2.12 | 412 |
| 1 | 1448 | Sugar, jam, honey/other sugary foods | 4 | .66 | 1223 |
| 1 | 1481 | Other food products | 4 | .72 | 1828 |
| 1 | 1518 | Coffee, tea, cocoa, and nutritional beverages | 4 | .42 | 463 |
| 1 | 1544 | Mineral waters, soft drinks, and juices | 4 | .51 | 485 |
| 2 | 2 | Alcoholic beverages and tobacco | 2 | 2.76 | 351 |
| 3 | 3 | Clothing and footwear | 2 | 3.4 | 26,223 |
| 4 | 4090 | Heating oil | 4 | .69 | 9 |
| 5 | 5001 | Furniture, furnishings, and floor coverings | 3 | 1.36 | 5465 |
| 5 | 5070 | Household textiles | 3 | .3 | 241 |
| 5 | 5100 | Household appliances | 3 | .57 | 6299 |
| 5 | 5140 | Glassware, tableware, and household utensils | 3 | .29 | 280 |
| 5 | 5200 | Tools for house and garden | 4 | .33 | 106 |
| 5 | 5221 | Goods for routine household maintenance | 4 | .5 | 1288 |
| 6 | 6070 | Medical products | 4 | .21 | 47 |
| 8 | 8006 | Telecommunication equipment | 3 | .18 | 691 |
| 9 | 9001 | Audiovisual, photographic, and IT equipment | 3 | .79 | 9182 |
| 9 | 9211 | Games, toys, and hobbies | 4 | .37 | 12,713 |
| 9 | 9300 | Plants, flowers, and garden products | 4 | .48 | 289 |
| 9 | 9555 | Writing and drawing materials | 4 | .14 | 594 |
| 12 | 12021 | Personal hygiene articles | 4 | .93 | 2741 |
| 12 | 12150 | Electrical appliances for personal care | 4 | .05 | 421 |
| 12 | 12160 | Personal effects | 3 | .61 | 150 |
| Total | – | – | – | 24.502 | 75,311 |

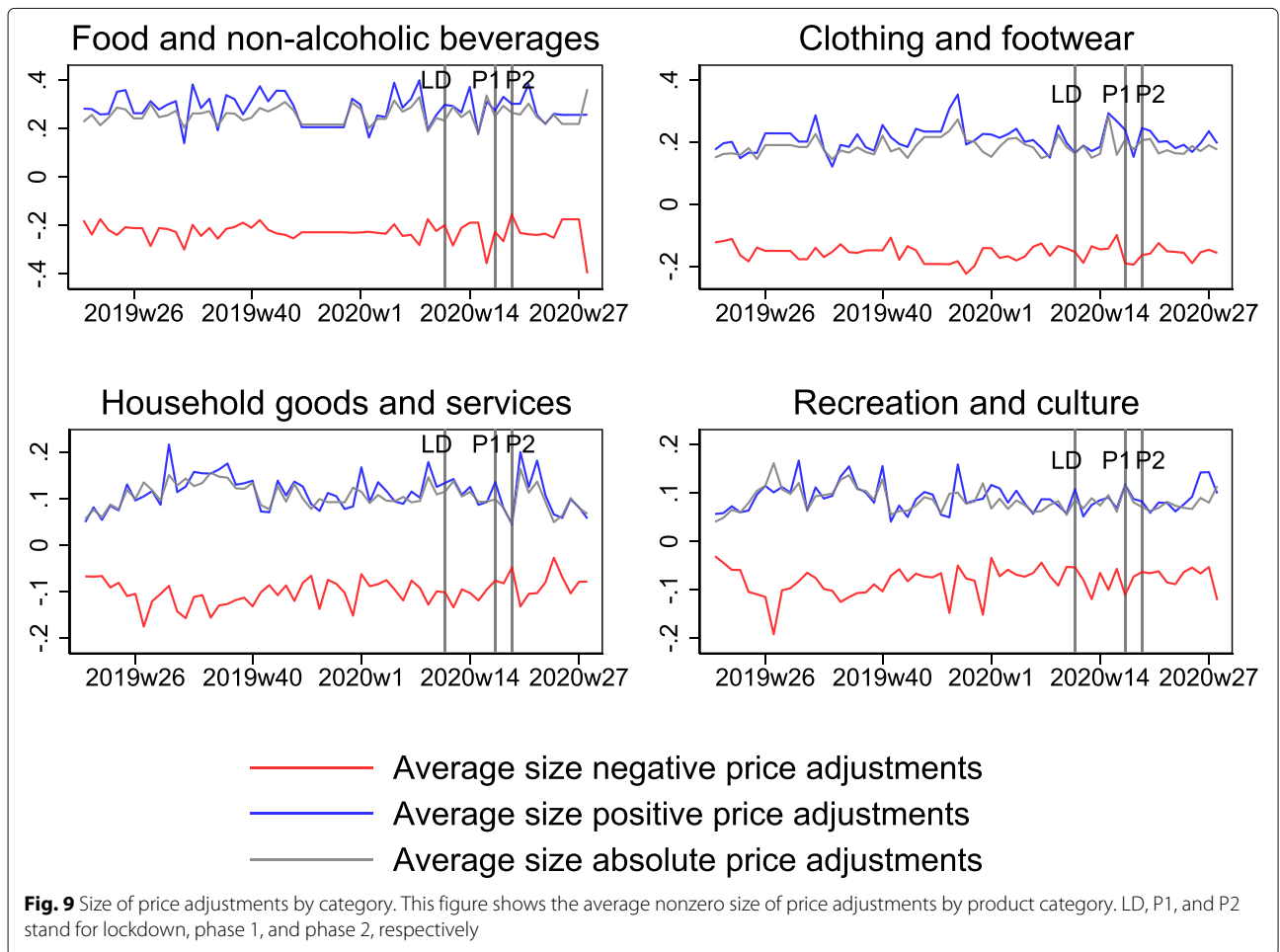
Weights as in the official CPI for 2020

¹⁸Also, products traded online have on average higher price adjustment frequencies as suggested in Rudolf and Seiler (2020), who look at Swiss microdata underlying the CPI.

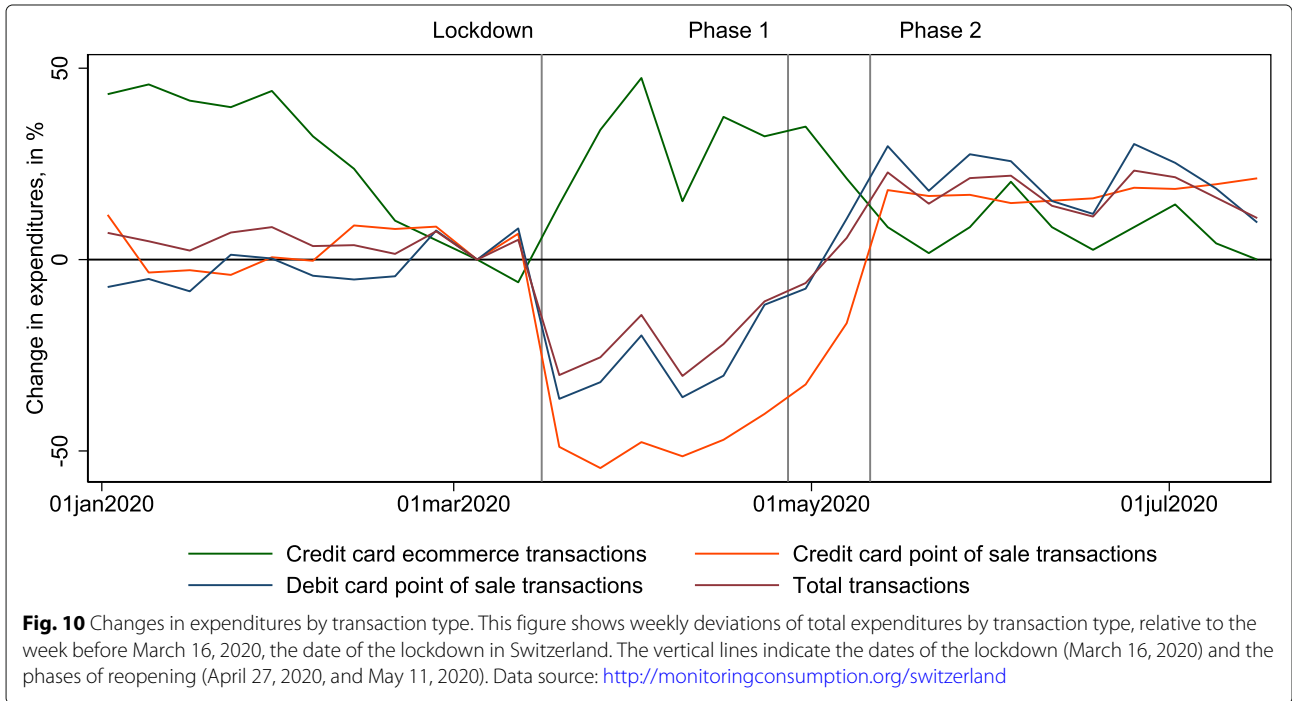


Appendix 2. Size of price adjustments





Appendix 3. Changes in expenditures by transaction type



Abbreviations

CEPR: Centre for Economic Policy Research; COVID19: Coronavirus (19); CPI: Consumer price index; KOF: KOF Swiss Economic Institute; LD: Lockdown (March 16, 2020); P1: Reopening phase 1 (April 27, 2020); P2: Reopening phase 2 (May 11, 2020); SFSO: Swiss Federal Statistical Office

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Authors' contributions

The authors contributed equally to the paper. The online data is collected by Alvarez. The authors read and approved the final manuscript.

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Availability of data and materials

We have posted the daily inflation data on our website. It is thus publicly available.

Competing interests

None.

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