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# Promotion Ban and Heterogeneity in Retail Prices during the Great Lockdown

## Abstract

We study the impact of the Belgium lockdown on retail prices using a unique dataset tracking daily prices and promotions for various products in different stores and retail chains. Two distinctive features of our analysis are the ban on promotions during the first two weeks of the lockdown, and the presence of local pricing retail chains (LP) competing with uniform (national) pricing retail chains (UP). We decompose the price changes into the regular price, the frequency, and the size of promotions. The sale price (i.e., the price paid by consumer purchasing on "sale") increased by 7% within two weeks and by 2.5% within three months. We then provide an heterogeneity analysis of the regular price variation across stores, retailers, products, and over time. We show that LP chains reacted the most to the lockdown with spatial heterogeneity. The heterogeneity in price response also suggests that the price increase was not driven by cost inflation.

JEL-Codes: D220, E300, E310, L110.

Keywords: Covid-19, pricing, lockdown, retailers.

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## 1. Introduction

The COVID-19 pandemic has represented a major factor of disruption worldwide. To contain the pandemic in 2020, most European countries adopted very restrictive measures, limiting mobility across cities, closing schools, restaurants, and non-essential shops. Concerns were raised regarding price gouging to the detriment of consumers (ILO, 2020). In the UK, month-to-month inflation was 2.4% during the first month of the lockdown, and more than half of this inflation is accounted for by a fall in the number of promotion transactions (Jaravel and O'Connell 2020a). The *Great Lockdown* also changed the spending pattern, creating a gap between official and real inflation (Blundell *et al.* 2020*;* Diewert and Fox 2020; Jaravel and O'Connell 2020a; Seiler 2020), with excessive inflation primarily for food and beverage (Cavallo 2020) as a consequence of a massive shift in demand towards at-home eating and drinking.

The inflation may be partly accounted for by supply chain and cost inflation. Many manufacturers had to readjust their production process, particularly their packaging process,[1] and there were many disruptions along the supply chain. Another source of cost increase could be the safety measures imposed on retail chains that could be partly shifted on the retail prices. Besides the cost inflation, the price increase can also be explained by the reactions of retail chains to the change in the local conditions, such as the demand shift due to panic buying and excessive stockpiling, the time restriction for shopping, and the mobility restrictions. The competitive pressure among local stores was also temporarily relaxed. Different retailers could have reacted differently to such changes in market conditions.

In this paper, we study how retail chains adjusted their prices immediately after Great Lockdown in Belgium and decompose the determinants of the price increase. We also analyze the long-lasting effect by tracking the (daily) prices several months after the lockdown. Belgium is an interesting place to look at for two reasons. Firstly, and this is rather unique, there are in Belgium retail chains pricing

[1] Demand from school canteens and companies in large packaging sizes (flour, toilet paper, canned food, rice, pasta) was shifted into households' demand in smaller packaging sizes. This caused a packaging problem for manufacturers and extra cost to do all the packaging in small sizes. See for example, https://packagingeurope.com/how-will-the-covid-19-crisis-impact-the-packaging-sector/.

locally (local pricing retailers LP) that compete with retail chains pricing nationally (uniform-pricing retailers UP). This allows us to study how different chains with similar products facing similar shocks adjusted prices to new market conditions. Secondly, to contain panic buying and excessive stockpiling, the Belgian government imposed a *strong* ban on promotional offers during the first two weeks of the lockdown.[2] We analyze how prices responded to this policy across retail chains, stores, and products. Moreover, since the ban was just temporary, we check whether both the frequency and the extent of promotions reverted to the pre-ban level.

We use a unique dataset on daily posted prices and promotions at the store and the product barcode level. We consider a selection of 137 branded products from different categories offered by the major retail chains in Belgium. We focus on branded products because they are homogenous products sold widely by the different stores[3]. A distinctive feature of our dataset is the daily information on posted prices at the store level, the size of the discounts, and further details on all products. Unlike scanner prices widely used in the literature, which represent transaction prices retrieved from the purchase of a sample of households, our data allow us to constantly monitor posted price changes and track how the same product, identified by its barcode, is sold in different stores and retailers on the same day. Indeed, posted prices have the key advantage of being unconditional on transactions.. It enables us to concentrate on retailers' pricing strategies and explore patterns of heterogeneity across stores.

It is worth noting that these posted prices are not conditional on the daily demand and availability of the different products in the different stores (Einav *et al.* 2008). Our posted prices and promotions are observable daily for all products across all stores, regardless of the daily transactions in the different stores. Furthermore, unlike Homescan scanner data, we can decompose the daily price change into changes of the regular price, the promotion frequency, and the size of promotions. What we cannot observe is whether consumers purchased more "on-sale" (Griffith *et al* 2016) as we have no

[2] See l'arrêté ministériel, March 18, 2020. http://www.ejustice.just.fgov.be/eli/arrete/2020/03/18/2020030331/moniteur From April 4 to May 4, only promotions decided before the ban were allowed. Moreover, it is important to notice that some retail chains adopted different discount practices to compensate consumers for the lower number of discounts. For example, Delhaize offered a 5% reduction on the total purchasing amount, Colruyt offered 3% (vouchers for people who have an XTRA card), Carrefour gave members extra bonus points (e.g. 10% discount when spending 50 euro). Unfortunately, this information is not observable to us.

[3] Branded products imply that fresh fruits and vegetables are excluded. Those products experienced a large price increase in 2020 relative to 2019 (e.g., because of high pork prices as a result of the swine fever, meteorological factors mostly affecting fruit prices). As a result, our analysis shut down the impact of such non-COVID related factors that led to higher prices..

information on purchasing decisions. Our objective is to assess the impact of the lockdown and promotion ban on the pricing strategy of the retail chains. Our paper complements recent research using transaction data to estimate the impact of the shift in consumption patterns on inflation measures (e.g., Ivancic *et al.*, 2011; Jaravel, 2019; Kaplan and Schulhofer-Wohl, 2017; Jaravel and O'Connell, 2020b).[4]

We find that, just after the announcement of the pandemic by the World Health Organization (WHO) on March 11, 2020, supermarket chains increased their regular prices --- the posted price a store applied --- by approximately 1.3% on average, and this price increase persisted over time. Starting from March 19, one day after the implementation of the lockdown, Belgian supermarkets were forbidden from offering discounted prices in the first two weeks of the pandemic.[5] Tracking promotion offers across products, stores, and retail chains during and after the promotion ban, we find that when promotions were restored, the frequency of promotion offers remained lower (7.5%) than the pre-lockdown level (13.3%), confirming the short-run result of Jaravel and O'Connell (2020b)[6]. Promotion frequency almost returned to their pre-lockdown level during the second half of the year, but the promotion size was reduced. The sale price (i.e., the price paid by consumers purchasing on "sale"), increased by approximately 7% on average within two weeks, as a consequence of the promotion ban and the regular price increase. We also find that the sale price had increased on average by 2.5% within three months and that, by the second half of the year, prices went down but did not completely revert to their pre-lockdown levels.

The second set of results relates to the price heterogeneity across retail chains and notably between LP and UP chains. First, we show that prices only increased in LP stores, while they did not vary in UP stores. As UP chains were the high price retailers, the price gap between UP and LP retailers decreased significantly. Second, retail chains started increasing prices at different dates: one chain acted as a price leader, increasing prices the week before the lockdown and other retail chains followed suit. Third, the regular price increase was highly heterogeneous, with peaks of 4% in the densely populated area of

[4] Using transactions data, Surico *et al* (2020) find a fall of 40-50% in the spending of British households during the first three months of COVID-19 crisis with most of the consumption reduction concentrated in the retail, restaurants, and transport.
[5] The promotion ban did not cover price matching strategy used by some retail chains to match the lowest local price.
[6] These authors found, using scanner data, a reduction in both the number of promotional offers (promotion supply) and the quantity of discounted products purchased by consumers (promotion demand).

Brussels. Fourth, significant heterogeneity within chains also existed. For instance, a subset of Carrefour stores increased on average regular prices by 4-5%, while other stores kept prices constant.

These findings suggest that the shock of the COVID-19 pandemic on prices may not be related to supply-side factors like, for instance, an increase in marginal costs. As we only focus on national and international branded products, an increase in cost due to a disruption of the supply chain would have affected all stores in Belgium similarly, including UP retailers.[7] Yet, we find that the increase in price did not occur in all retail chains and that, even within the same chain, not all stores increased prices. Our findings hint more at a demand-side effect. Stores increased prices just after the pandemic was announced but before the lockdwon was implemented, possibly due to anticipation or a reaction to a sudden increase in demand. For example, retailers had to cope with panic buying and excessive stockpiling, which has been well-documented in the UK around the announcement of the pandemic (O'Connell *et al.*, 2020). The government implemented the promotion ban with the explicit motive of limiting panic buying during the lockdown. Nevertheless, only LP retailers increased prices and did so mostly in urban areas. This evidence could suggest that retailers were more concerned about panic buying in those stores with historically high demand.[8]

Our paper adds to several strands of the literature. First, it contributes to the emerging literature on the impact of COVID-19 on prices and complements with posted price data the recent use of transactions data (scanner data) to improve inflation measures (Blundell *et al.*, 2020; Cavallo, 2020; Diewert and Fox, 2020; Jaravel and O'Connell, 2020a; Seiler, 2020). We focus on pricing strategies used by different retailer chains using both posted prices and promotional offers. To the best of our knowledge, there is scant evidence on retailers pricing strategies during pandemic and promotion ban over a large set of consumables.[9]

Second, this paper contributes to the literature on uniform pricing, which has received significant attention in the last decades. Uniform prices are common in many industries, ranging from the movie

[7] A symmetric shock in marginal cost could be shifted to prices differently according to differences in demand elasticity across chains and stores. However, we think this is unlikely, as the chain with higher prices and notably less elastic demand did not raise prices although it would have been able to.

[8] Panic buying and excessive stockpiling might be less concerning for stores with lower demand since they have a lower risk of running out of stock.

[9] There is evidence of price gouging in online markets related to hand sanitizers and masks, but the focus of the paper is on reputation and incumbency (Cabral and Xi 2020).

industry (Orbach and Einav, 2007) to supermarket chains (Della Vigna and Gentzkow, 2019). More related to the spirit of this paper, Della Vigna and Gentzkow (2019) found that most US supermarket stores charge nearly uniform prices despite wide variation in consumer demographics and local competition. Uniform pricing within chain can be accounted for by chain-specific demand, inertia (i.e., agency frictions, behavioral factors), or brand image concern. Indeed, Hitsch *et al.,* (2019) found less price heterogeneity at the barcode level within chains than across chains. They argue that the demand curves are specific to each chain and that this might render less appealing the local pricing. Our analysis reveals that UP retailers did not react to the lockdown, whereas the LP retailers reacted sequentially by raising their prices non-uniformly across their stores. We find that a large part of heterogeneity in the price change is driven by local pricing, which is consistent with a local swing in demand effect.[10]

Finally, our paper also relates to a recent paper by Cavallo (2017), who showed *almost* uniform online vs. offline pricing for the same retail chains. In contrast, we find that online and offline prices set by the same retail chain in the same location were significantly different before the lockdown (with higher online prices). Within the first two weeks of the lockdown, the offline prices increased slightly more than online prices, and this difference persisted within three months .

The paper is organized as follows. In Section 2, we discuss our dataset. In Section 3, we present our results. In Section 4, we explore heterogeneity across stores, retailers, and products. In Section 5, we present concluding remarks. Some additional results are presented in the Online Appendix.

## 2. Data

We use a unique dataset of daily prices and promotions for all major retail chains in Belgium collected at the barcode levels by an external data broker (Daltix). In the Online Appendix (Table A1), we present a summary of the information on the stores, the market shares of each retailer, and the number of stores available in our sample. Two of the identified retailers, Delhaize and Albert Heijn, which belong to the same group, Ahold Delhaize (AD), adopt a uniform pricing strategy (UP retailers), and their information was collected from a representative store. This retail group has a market share of

[10] See Gagnon and López-Salido (2020) for a similar analysis of retailers' price response to local shocks in demand.

18.6%. For the other retailers --- Carrefour, Colruyt Lowest Prices and Collect & Go (belonging to Colruyt Group), Intermarche, and Match --- adopting local pricing strategies (LP retailers), data were collected on a subset of the available stores, whose location covers the three regions of Belgium (i.e., Brussels, Flanders, and Wallonia). Together, these retailers cover more than 70% of the total market shares in Belgium, with Colruyt being the largest retail chain (approximately 26%), followed by Carrefour (18.7%).

Our dataset contains information on 137 products, belonging to 17 different categories: pasta, rice, flour and sugar, sauces, toppings, cheese and butter, canned vegetables, breakfast cereals, jam and chocolate pasta, snacks, coffee, milk, alcohol, water, beer, soda, and juice. Products are identified using their Stock Keeping Unit, SKU, a scannable barcode. Within a category, products were selected from the major brands (e.g., Barilla, Minute Maid, Nutella) to compare homogenous products across stores and chains. Focusing on branded products implies similar cost shocks across stores and chains. A summary of all products available in our dataset is provided in Online Appendix (Table A2).

Our dataset contains information regarding the regular price charged by each store and the promotion offers (if any) on a daily basis at the barcode level. Promotions are mainly set at the national level, but the size of the discount can vary across stores both within and across chains. To avoid information redundancy and given the small frequency of price changes within a week, we aggregate daily information into weekly data using the mode of prices and discounts over that week.

In the analysis, we will distinguish between the following price components. The *regular price* is the posted price at which a single store offers a product non-inclusive of discount. The *promo price* is the price at which a product is offered, inclusive of a discount. Discounts can be of different types (percentage, cents, quantity). The local price-matching, usually employed by Colruyt (both in its offline and online divisions), is not considered as a promo price but rather as a regular price.[11] As a result, such local price-matching was authorized during the promotion ban. The *sale price*, which is the price paid conditional on purchasing on "sale" is given by[12]:

[11] See https://www.colruytgroup.com/wps/portal/cg/en/home/brands/Colruyt%20Lowest%20Prices

[12] Our posted data do not allow us to observe whether consumers purchase on "sale" or not. This purchasing "on sale" is only observable with transactions data. So, in the following we define the sale price as the price conditional on purchasing "on sale". When you buy "on sale" you pay the regular price if no discount is available and you pay the discounted price when

$$sale\ price = regular\ price - Prob\ (discount) \text{ x } discount.$$

## 3. Average price effect in the short and long run

To highlight the impact of the Belgium Lockdown and the promotion ban on prices, we employ a before-and-after specification. We start our analysis by estimating the average effect with the following regression, pooling all products and stores from all chains together:

$$\log(p_{ijkt}) = \alpha + \beta\ POST + \gamma_{ijk} + \varepsilon_{it},$$

where *p={regular, promo, sale}* is the price of product *i* in store *j*, from retailer chain *k*, in the week *t*. *POST* is an indicator that takes a value equal to 1 in the weeks following the introduction of the lockdown (from March 18 to the end of June) and zero for the pre-lockdown period (January 1- March 17). To identify the average effect in the second half of the year, we also include a dummy *July to Nov* that takes value equal to 1 in the period starting on July, 1 and 0 in otherwise. $\gamma_{ijk}$ identifies the product-store-retailer fixed effects. Our coefficient of interest is $\beta$, which can be interpreted as the average price variation in the post-lockdown period across every store and product. Using a log-transformation of the dependent variable, the average price variation can be interpreted for small coefficients in percentage changes. We consider three different time windows. First, we consider the two weeks during which there was a ban on discounts. From March 19 to April 3, all promotions were banned. This specification allows us to assess the immediate effects of the lockdown and promotion ban on prices. Second, we consider a three-month period to track the price effect of reverting to promotions and whether there was a return to pre-lockdown levels. Third, we consider a nine-month period running up to the end of November to verify whether the price hike and the promotion fall persisted.[13]

Table 1 presents the main results. The left panel (first three columns) shows the regular price change over the three periods following the implementation of the lockdown. Due to the composition of the sample, we estimate our regression by means of Weighted Least Squares (WLS) and use the market share of each retailer as weights.[14] This way, we avoid that our results are driven by the LP

there is a promotion. So the "sale price" is the regular price minus the expected discount (probability of discount times the size of the discount).

[13] The second lockdown was introduced in Belgium on November 2. We excluded December as during the Christmas period, promotional sales might increase for reasons different from those studied in this paper.

[14] The weights are set such that each UP retailer represented by one store is weighted by its market share. For each LP retailers, each store is weighted as a fraction of this retailer's market share to add up to the total market share of this retailer.

stores, with multiple data points, compared to the UP stores, with one daily observation each.[15] We find that during the first two weeks of the lockdown, in which mobility was restricted and there was a promotion ban, the regular prices increased by approximately 1.3% on average. Interestingly, this sudden increase in the regular price persisted during the following three months. Indeed, prices remained at a higher level up until the end of June. The third column shows that regular prices remained at a higher level during the second half of 2020, but to a lesser extent

The impact of the lockdown on the frequency and size of promotion are indicated in the center panel of Table 1. We indicate two sets of results. First, we assess the impact of the lockdown on the promotion frequency. This is done by regressing

$$OFFER_{ijkt} = \alpha + \beta \, POST + \gamma_{ijk} + \varepsilon_{it},$$

where the variable $OFFER_{ijkt}$ takes the value of 1 if, during week *t*, a product *i* is in promotion in store *j* from chain *k*, and 0 otherwise. As the dependent variable is a dummy, the estimated coefficient is expressed in percentage points. We find that during the first two weeks of the promotion ban, promotion frequency dropped from 13.3% to zero (that is a reduction of 13.3 pp). When considering the period of three months after the lockdown, the promotion frequency was reduced by 5.8 pp (that is a post-lockdown promotion frequency of 7.5%).[16] In the second half of the year, the promotion frequency remained at a lower level also in the second half of 2020. On the promotion size, Table 1 indicates that promotion prices increased relative to pre-lockdown by 3.1% within three months after the lockdown. This increase was partly offset in the second part of the year (July-November), with an increase by approximately 1.9% compared to the pre-lockdown period.

[15] In the Online Appendix, we also provide robustness checks with estimates in the absence of weights for market shares and by retail chain (Tables A3 and A4).
[16] One retailer chain, Delhaize, starting from April 3 introduced a solidarity discount of 5% of any product so as to " avoid a rush of specific promotions in stores"

## Table 1
### Average effect (All products)

| | **Regular Price (percent change)** | | | **Promo frequency (percent point)** | | | **Promo Price (percent change)** | | **Sale Price (percent change)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 weeks | 3 months | 9 months | 2 weeks | 3 months | 9 months | 3 months | 9 months | 2 weeks | 3 months | 9 months |
| **POST 3 weeks** | **0.013*** ** | | | **-0.133*** ** | | | | | **0.072*** ** | | |
| | 0.002 | | | 0.004 | | | | | 0.007 | | |
| **POST to June** | | **0.010*** ** | **0.009*** ** | | **-0.058*** ** | **-0.056*** ** | **0.031*** ** | **0.027*** ** | | **0.026*** ** | **0.025*** ** |
| | | 0.001 | 0.001 | | 0.003 | 0.003 | 0.001 | 0.002 | | 0.003 | 0.003 |
| **July to Nov** | | | **0.007*** ** | | | **-0.020*** ** | | **0.019*** ** | | | **0.007*** ** |
| | | | 0.001 | | | 0.003 | | 0.003 | | | 0.002 |
| Observations | 170326 | 359110 | 643387 | 171735 | 333324 | 619737 | 98538 | 198707 | 170326 | 359110 | 643387 |
| Chain level | No | No | No | Yes | Yes | Yes | No | No | No | No | No |
| Store level | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ban included | Yes | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes |

Note: Ban refers to the period between March,19 and April 3 in which a ban on discounts was imposed. These observations are removed for the 'promo price'. Standard errors clustered at a store level. Log-transformation of the dependent variable for regular price, promo price, and sale price. * p< 0.1, ** p<0.05, *** p<0.01. We estimate the coefficient using WLS. The weights are calculated based on the retailer's market shares. Weights are set so that each UP retailer weights as its relative market share compared to other retailers. For LP retailers, the weights are set so that each store weights as a fraction of the retailer's market share. The sum of these weights then equals the market share of the LP retailer relative to other chains.

Combining the increase in the regular and promotion prices with the fall of promotion frequency, we estimate the lockdown incidence on the sale prices paid by consumers. The right panel of Table 1 shows that within two weeks of the lockdown, the sale price increased on average by 7.2%. This is a consequence of both the increase in the regular price and the ban on promotions. The sale price increase persisted when restrictive measures were relaxed, with an average increase of approximately 2.6% within three months of the lockdown. In the second part of the year, the sale price increase was partially offset as promotions started again. In the Online Appendix (Table B1), we run a placebo test over the same weeks in 2019, showing that the regular price did not change, and if any, the change within three months was negligible (and of different signs).

# 4. Heterogeneity Analysis

## 4.1 Product Heterogeneity

The above analysis might hide a significant heterogeneity across products. To explore product heterogeneity, we estimate the price change for each product category decomposing between regular prices, promotion prices, and sale prices. The results are presented in Table 2. Also in this case, estimates are obtained by WLS using market shares as weights. One can see that the regular price increased within three months of the lockdown for most product categories. The highest price increases concerned pasta (1.9%), canned vegetables and fruit juices (2%), followed by toppings (1.8%), rice (1.6%), breakfast cereals, jam and chocolate pasta (approximately 1.5%). These products were probably in high demand just before and during the first weeks of the lockdown. O'Connell et al. (2020) show that such a rise in demand mainly occurred in the run-up to the UK lockdown, as most households increased their demand for storable food staples sharply.

There is more heterogeneity across product categories when considering a large time span (second column). For some categories, we continue to observe a price increase compared to the pre-lockdown period, suggesting that price reductions did not compensate for the initial price increase (e.g., rice, sauces, cheese, and butter). For other categories, the price reduction in the second period more than offset the initial price increase (e.g., snacks, milk, sauces, flour, and sugar). There are still other categories featuring a persistent price increase (e.g., pasta, beer, soda).

**Table 2**
**Average effect per category**

| | **Regular Price** | | **Promo Price** | | **Sale Price** | |
|---|---|---|---|---|---|---|
| | POST to June | July to Nov | POST to June | July to Nov | POST to June | July to Nov |
| **Pasta** | **0.019*** | **0.019*** | **0.083*** | **0.009*** | **0.075*** | **0.023*** |
| | 0.002 | 0.003 | 0.004 | 0.005 | 0.014 | 0.014 |
| **Rice** | **0.016*** | **0.009*** | **-0.007** | **0.022*** | **0.053*** | **0.038*** |
| | 0.002 | 0.001 | 0.002 | 0.002 | 0.003 | 0.004 |
| **Flour and sugar** | **0.001** | **-0.017*** | **0.024*** | **-0.033*** | **0.033*** | **-0.009** |
| | 0.001 | 0.004 | 0.004 | 0.003 | 0.007 | 0.004 |
| **Sauces** | **0.003*** | **-0.017*** | **-0.002*** | **0.000** | **0.004** | **0.003** |
| | 0.002 | 0.004 | 0.001 | 0.001 | 0.003 | 0.003 |
| **Toppings** | **0.018*** | **0.006*** | **0.111*** | **-0.007*** | **0.068*** | **0.008** |
| | 0.002 | 0.002 | 0.003 | 0.004 | 0.007 | 0.003 |
| **Cheese and butter** | **0.004** | **0.011*** | **0.006** | **-0.000** | **0.022** | **0.003** |
| | 0.003 | 0.002 | 0.021 | 0.030 | 0.008 | 0.005 |
| **Canned Vegs** | **0.020*** | **-0.003** | **0.119*** | **0.030*** | **0.102*** | **0.065*** |
| | 0.003 | 0.005 | 0.003 | 0.004 | 0.022 | 0.018 |
| **Breakfast Cereals** | **0.014*** | **0.021*** | **-0.008*** | **-0.010*** | **0.028*** | **0.025*** |
| | 0.002 | 0.004 | 0.002 | 0.002 | 0.005 | 0.005 |
| **Jam/Chocopasta** | **0.015*** | **0.007*** | **0.047*** | **0.049*** | **0.031*** | **0.027*** |
| | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 | 0.003 |
| **Snack** | **0.005*** | **-0.001** | **0.053*** | **0.043*** | **0.045*** | **0.034*** |
| | 0.002 | 0.002 | 0.003 | 0.005 | 0.008 | 0.008 |
| **Coffee** | **0.005*** | **-0.003** | **0.014*** | **0.006** | **0.035*** | **0.024** |
| | 0.001 | 0.002 | 0.003 | 0.013 | 0.006 | 0.012 |
| **Milk** | **0.007*** | **0.000** | **-0.007*** | **-0.013*** | **0.028*** | **0.009*** |
| | 0.001 | 0.001 | 0.002 | 0.002 | 0.002 | 0.002 |
| **Alcohol** | **0.003** | **0.005*** | **-0.008*** | **-0.048*** | **0.013*** | **0.005** |
| | 0.001 | 0.002 | 0.003 | 0.003 | 0.002 | 0.002 |
| **Water** | **0.007*** | **0.002** | **0.106*** | **0.005** | **0.036*** | **0.004** |
| | 0.003 | 0.001 | 0.003 | 0.003 | 0.014 | 0.004 |
| **Beer** | **0.005*** | **0.031*** | **0.026*** | **0.118*** | **0.005** | **0.042*** |
| | 0.001 | 0.004 | 0.004 | 0.008 | 0.007 | 0.011 |
| **Soda** | **0.005** | **0.0010** | **0.007*** | **-0.000** | **0.028*** | **-0.014** |
| | 0.004 | 0.005 | 0.003 | 0.004 | 0.010 | 0.011 |
| **Juice** | **0.020*** | **0.024*** | **0.065*** | **0.062*** | **0.037*** | **0.039*** |
| | 0.002 | 0.002 | 0.005 | 0.005 | 0.004 | 0.005 |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Discount Ban included | Yes | Yes | No | No | Yes | Yes |

Note: Discount Ban refers to the period between March 19 and April 3. These observations are removed for the 'promo price'. Standard errors clustered at a store level. Log-transformation of the dependent variable for regular price, promo price, and sale price. * p< 0.1, ** p<0.05, *** p<0.01. We estimate the coefficient using WLS. The weights are calculated based on the retailer‘s market shares. Weights are set so that each UP retailer weights as its relative market share compared to other retailers. For LP retailers, the weights are set so that each store weights as a fraction of the retailer’s market share. The sum of these weights then equals the market share of the LP retailer relative to other chains.

Considering the promotion prices, they increased for most products within three months of the lockdown. The most significant increases were for toppings (11.1%) and canned vegetables (11.9%), water (10.6%), and fruit juices (6.5%), whereas the largest price decrease was for alcohol, milk, and breakfast cereals (approximately -0.7%), These results could be accounted for by the comparison-shopping hypothesis. When the promotion ban was lifted, stores were competing more intensely to attract consumers. To do so, they use "loss leaders" (e.g., alcohol, milk, etc.), which are products that people always buy and use as a proxy for a shop's overall price level (Johnson, 2017).

As indicated in the last two columns of Table 2, the sale prices increased for all product categories within three months of the lockdown. This sale price increase was not offset by any decrease during the second period except for flour and sugar.

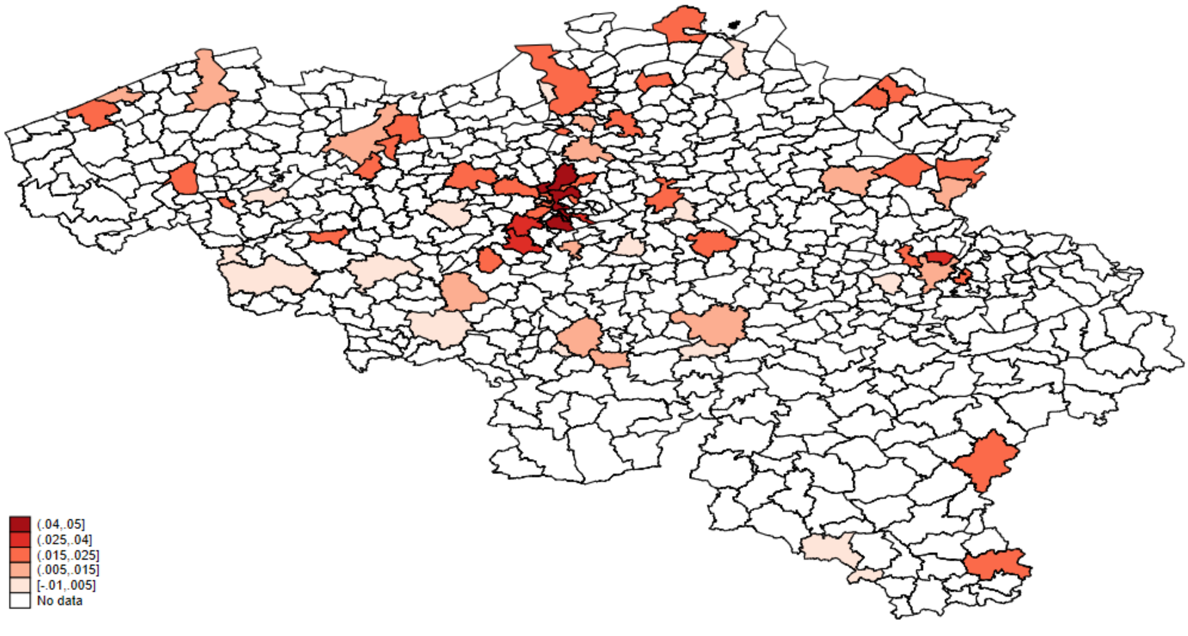
### 4.2 Heterogeneity across space

As discussed, Belgium offers a unique setup where local pricing retailers (LP) compete with uniform pricing retailers. Spatial price discrimination is not necessarily bad for consumers. It can increase demand and benefit consumers depending on demand curvature and pass-through rates (Aguirre *et al.* 2010). The LP retailers should be more prone to adjust local prices to new conditions, such as restricted mobility, demand shift due to stockpiling, and at-home consumption. To shed some light on spatial heterogeneity, we restrict attention to changes in the regular prices occurring within three weeks from the WHO announcement on March 11 to further account for possible anticipation strategies. For example, anticipating the Belgian lockdown, restriction to mobility, and surge in demand, supermarket chains might have increased their prices some days before the actual implementation of the lockdown (the official Lockdown and promotion ban started on March 18 in Belgium).

Figure 1 presents a spatial dispersion map of the average regular price increase in LP retailers. Since these retailers sell the same set of products, the map shows variation in the price change across Belgian municipalities for homogeneous products. The white areas represent the areas for which we do not have price data from the LP retailers. Figure 1 suggests that the largest price increase (dark red) of more than 4% arises in the Brussel area (e.g., Brussels, Grimbergen, Ixelles, Uccle, Wemmel), which is also the most densely populated and among the wealthiest areas in Belgium. Such price increase mainly occurs in stores belonging to Carrefour. Price hikes around 2.5% and 4% also arise in Liège, Charleroi, few municipalities bordering the Brussels district, and at the border with Luxembourg (i.e., Bastogne). This occurs primarily in stores belonging to Colruyt Low Price. More details on the spatial heterogeneity in the regular price increase within each retailer are displayed in Figures A2 to A4 in the Online Appendix.

Interestingly, the stores with the highest price variation also exhibit higher prices pre-pandemic (see Table B3 in the Online Appendix). The fact that these stores are also mostly located in urban areas can suggest that they usually face a high (less elastic) demand. Our results suggest that LP chains increased prices more in areas where demand was already high and where, therefore, the largest surge in demand was more likely to occur.

**Figure 1**
**Spatial heterogeneity in price variation for LP chains**

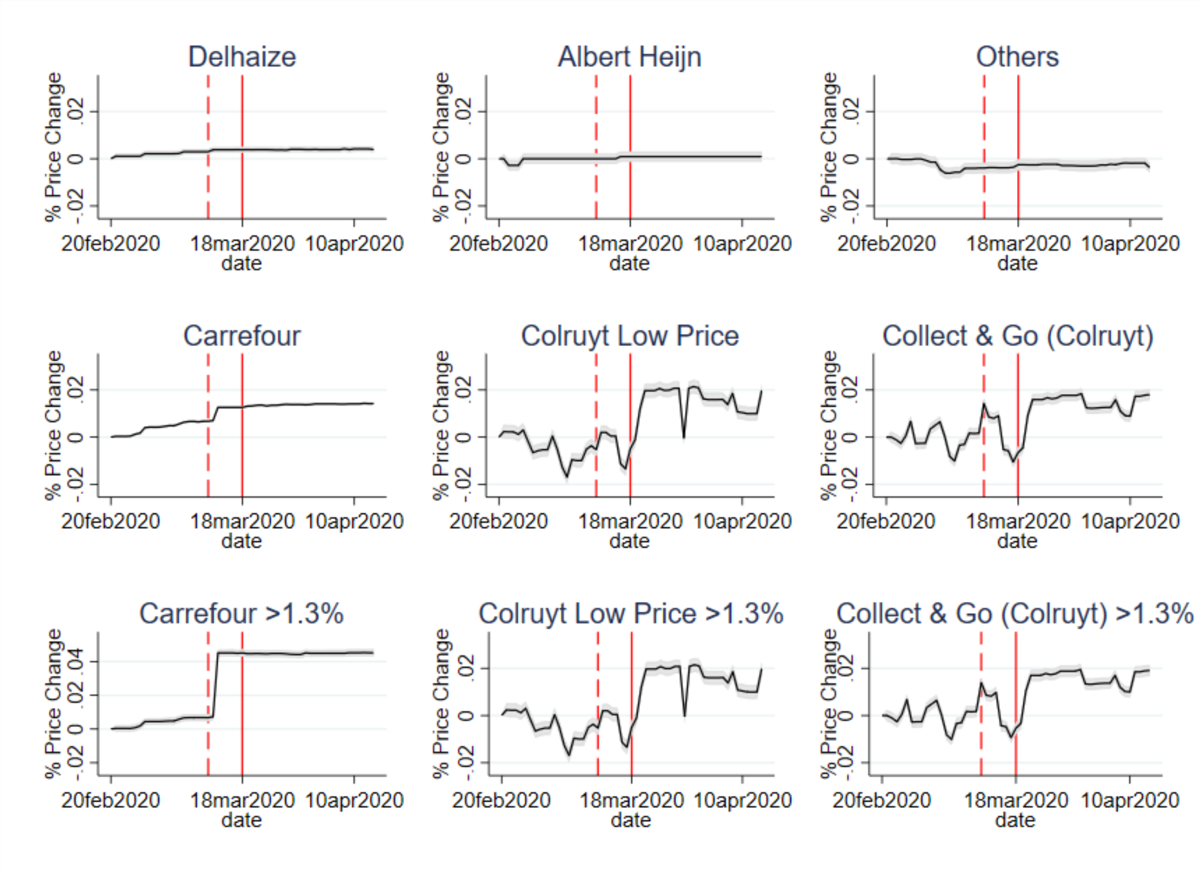



Average regular price variation for LP retailers in the period following the announcement of the pandemic by the WHO (March 11). The POST period includes the observation until March 31 (3 weeks).

## 4.3 Time and Retailer Heterogeneity

We now analyze the heterogeneity across retailers. The first dimension of heterogeneity is on the timing of the price change. To see whether retailers increased their prices simultaneously or sequentially, we can exploit the daily data on posted prices and concentrate on the period just before and after the lockdown, where most of the price changes were taking place. To this end, we concentrate on those retailers and stores with the largest price increase. In Figure 2, we plot the average price change for all products for each retail group using as a reference February 20. The *thick red line* identifies the date the lockdown was implemented, whereas the *dashed red line* identifies the date the WHO declared the pandemic.

**Figure 2**
**Time heterogeneity by retailer**




Average regular price variation in the period February 20 - April 15. The confidence interval is in gray. The lockdown in Belgium was implemented on March 18 (thick red line), whereas the WHO officially announced the pandemic on March 11 (red dashed line). Ahold Delhaize stores (e.g., Albert Heijn and Delhaize) are UP retailers, whereas all others are LP retailers. Colruyt Lowest Prices and Collect & Go are part of the same Colruyt Group, whereas Others include stores belonging to Intermarche and Match.

There are some interesting observations. First, the UP chains did not change their prices. Delhaize has a slightly upward trend that started before the pandemic, but prices remained stable during the lockdown. A similar pattern is present for its sister company, Albert Heijn.[17] On the contrary, local pricing retailers (LP) behaved very differently. Small retail chains (Match and Intermarche, included in 'Others') did not change prices, whereas large supermarket chains resorted to their LP strategy to increase their prices more substantially, but with different patterns. One possible explanation is that local pricing retailers, with enough market power, may be better equipped to match their prices to the local market conditions.. The fact that not all retail chains increased prices indicates that the price hike may not be caused by a general cost increase due to changes in supply conditions. In that case, we would have observed a generalized price increase also for UP retailers.

Second, Carrefour acted as a price leader among LP retailers and increased prices just after the WHO announcement of the pandemic, but one week before the Belgian lockdown. Colruyt Lowest Prices, which is typically a price-follower with an explicit local price matching strategy, followed suit, with the largest price increase one week after Carrefour. Given its price-matching strategy, it is not surprising to observe more volatile price changes for Colruyt Lowest Prices during the lockdown. It should also be noted that while price increases were larger for LP retailers, price levels were higher for the UP retailers. As a result, the price gap between UP retailers (Delhaize and Albert Heijn) and LP retailers (Carrefour and CG) decreased significantly during the lockdown (see Online Appendix, Table B2).

Third, Figure 2 also presents the average price change for the subgroup of highly reactive CG and Carrefour stores with a price increase above 1.3%. Interestingly, some Carrefour stores increased prices by as much as 4-5% just after the WHO pandemic, and that price increase persisted until mid-April. These stores are mainly located in the area of Brussels. The price change profile of CG stores is much more volatile across time. This is probably due to the local price-matching strategy adopted by CG, together with the local heterogeneity in price changes.[18] This retailer heterogeneity analysis is limited to the regular prices. The previous analysis suggests much larger price changes when considering changes in the frequency and size of promotion offers.

[17] See also Table A4 in the Online Appendix, which provides regular price changes by retailers.
[18] The spatial variation in prices for each LP chains separately is shown in figures A2 to A4 in the Online Appendix.

### 4.3 Heterogeneity in online/offline prices

In the UK, online prices increased substantially during the first month of the lockdown (Jaravel and O'Connell, 2020a). Our Figure 2 instead seems to suggest that online prices were on average less volatile than offline prices. However, such an aggregate price variation map might hide significant heterogeneity across products and time.

In this section, we exploit a specific feature of our dataset, that is the possibility to compare the daily prices of products sold by stores sharing the same location offline (Colruyt Low Prices) and online (Collect & Go). This is because Collect & Go pick-up points are usually just next to the Colruyt Lowest Prices stores, allowing to study more precisely heterogeneity in retail prices between offline and online sales of the same products in the same location.

To this end, we select from our dataset those stores belonging to the CG that share the same location. This implies selecting the following 20 stores, which are spatially distributed across all of Belgium: Fleron, Anderlecht, Ans, Arlon, Brugge Sint-Peiters, Deurne Zuid, Gosselies, Halle, Hasselt, Herstal, Hoogstraten, Jambes, Kuurne, Ledeberg, Lier, Merelbeke, Sint Denijs Westrem, Vilvoorde (Mutsaert), Waterlo, Wilrijk.

We run two analyses. First, we identify whether a given product *i* is systematically priced differently at time *t* in the same location *l*. To isolate any distortion resulting from the pandemic, we only focus on the pre-pandemic period using data from 2019. Indeed, we regress the regular price on a dummy *Online* (taking value equal to 1 if the product is sold by Collect & Go, and 0 otherwise). Second, we extend this model to the post-pandemic period by adding a variable *POST*, which captures the price variation of offline stores, and an interaction term *POST X Online*, which measures the additional price change of online stores.

Table 3 presents these results. In the first column, we can observe that in 2019 online prices were on average higher than those offline, with a price difference of 3.1%. This result suggests a pricing gap between online and offline and differs from the uniform offline-online pricing conclusions made by Cavallo (2017). One possible explanation for such heterogeneity comes from the price-matching strategy used by Colruyt Group, with Colruyt Lowest Prices matching local competitors' best prices and Collect & Go only matching comparable online prices.[19]

The last two columns of Table 3 show the average price variation of online prices after the implementation of the lockdown. We find that offline prices increased on average by 2.9% following the implementation of the lockdown (*POST*), while online prices increased to a lesser extent by 2%. This heterogeneity is significant not only within two weeks of the lockdown but also within three months. In the latter period, however, this price increase declined for both offline and online stores to 1.7% and 1.1%, respectively.

**Table 3**

**Online vs. Offline (Colruyt Group only)**

| | 2019 | 2 weeks | 3 months |
|---|---|---|---|
| **Online** | **0.031***** | **0.033***** | **0.031***** |
| | 0.005 | 0.003 | 0.004 |
| **POST 2 weeks** | | **0.029***** | |
| | | 0.002 | |
| **Online X POST 2 weeks** | | **-0.009***** | |
| | | 0.002 | |
| **POST to June** | | | **0.017***** |
| | | | 0.001 |
| **Online X POST to June** | | | **-0.006***** |
| | | | 0.002 |
| Observations | 174364 | 54400 | 116169 |
| ProductXRetailerXStore FE | Yes | Yes | Yes |
| Ban included | Yes | Yes | No |

Note: Online only refers to Colruyt Collect & Go. The stores selected for the analysis include Fleron, Anderlecht, Ans, Arlon, Brugge Sint-Peiters, Deurne Zuid, Gosselies, Halle, Hasselt, Herstal, Hoogstraten, Jambes, Kuurne, Ledeberg, Lier, Merelbeke, Sint Denijs Westrem, Vilvoorde (Mutsaert), Waterlo, Wilrijk, Standard errors clustered at a store level and presented in italics. Log-transformation of the dependent variable (regular price). * p< 0.1, ** p<0.05, *** p<0.01.

## 4. Conclusion

In this paper, we tried to unveil the price dynamics in retail chains in Belgium and decompose it into the regular price, frequency of promotions, and the size of promotions. Using a high-frequency

[19] See https://www.retaildetail.be/fr/news/food/voici-comment-colruyt-honore-sa-promesse-de-marque-%C2%AB-les-meilleurs-prix-aussi-en-ligne-%C2%BB

dataset on retail prices, we found a significant and substantial price increase for all food and beverage branded product categories. Such a price increase persisted over time for at least the second half of 2020. We also identified significant heterogeneity within and across chains. We find that regular prices only increased in those retail chains applying local prices, but with significant heterogeneity across time and space. One retail chain acted as a price leader, increasing prices one week before the implementation of the lockdown, while another chain increased prices the day after the lockdown. The price increase varied across space, with the largest price increase in the Brussels Capital Region, and other large cities.

Our analysis provides several implications for policymakers. First, we identify the unintended consequences of a ban on discounts. When the ban on promotion was reverted, the frequency and the size of the promotions did not return to their pre-ban level, resulting therefore in a ratchet effect. However, it is important to remark, that some retail chains started compensating consumers for the reduced frequencies of promotions by offering extra-points on loyalty cards or providing 5% discounts over the entire basket of consumption. One possible explanation is to speed up the payment at the cashier.

Second, our analysis tends to reject the hypothesis that the price increase was driven by cost inflation, because the uniform price retailers did not change their price. Our analysis suggests rather that price increases might have been produced by a demand shift occurring at the beginning of the COVID-19 pandemic (Keane and Neal 2021; O' Connell *et al.* 2020). This is because the increase in prices was immediate and started just after the WHO announced the pandemic. Furthermore, the price change across stores seems to be related to local demand conditions. The prices increased mostly in stores located in urban areas, which were already setting higher prices before the lockdown. This heterogeneous price response to a shift in demand is new as far as we know. So far, the literature has found some modest price changes in response to large local shocks in demand (e.g., storms, labor conflicts, such as studied in Gagnon and López-Salido 2020).

Third, complementing existing papers based on transactions data showing that CODIV-19 inflation was mainly driven by a reduction in the number of promotion transactions, our analysis suggests that the overall price change was a consequence of the combined effects of an increase in the regular price, and a persistent fall in the frequency and size of promotions. Such a decomposition has important implications for understanding the driver of inflation.

Fourth, retailers employing local prices were the best equipped to adjust their prices to new local conditions, keeping their prices below those set by UP retail chains. These results seem to confirm the conclusion by Della Vigna and Gentzkov (2019) that even if uniform pricing strategies might exacerbate inequality, they might protect consumers from opportunistic price response to sudden shocks.

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# ONLINE APPENDIX A

**Table A1**
**Supermarket chains and number of available stores**

| Retailer | Market share (%) | Pricing strategy | # stores |
|---|---|---|---|
| Albert Heijn (AD)<br>Delhaize(AD) | 18.6 | Uniform Pricing | 1<br>1 |
| Carrefour | 18.7 | Local Pricing | 46 |
| Collect & Go (CG )<br>Colruyt Lowest Prices (CG) | 26.6 | Local Pricing | 40<br>40 |
| Intermarche | 1.8 | Local Pricing | 3 |
| Match | 4.7 | Local Pricing | 4 |

Source: Source: FAS Brussels and Gondola.be 2019. Albert Heijn and Delhaize are part of the same group and the market share refers to the entire group Ahold Delhaize (AD). Similarly, Collect & Go and Colruyt Lowest Prices are part of the Colruyt Group (CG) and the related market shares are considered per group.

**Table A2**
**Product categories**

**Alcohol**
Absolute Vodka
Bombay Dry Gin
Eristoff Original
Gordon Dry Gin
Havana Club 3 y.
Jameson Blended Whisky
Jägermeister
Rum Bacardi carta bianca
Tanqueray London Dry Gin
Lawson Whiskey

**Beer**
Chimay Bleu 33cl
Corona Extra (35.4 cl)
Jupiler 25 cl.
Jupiler 50 cl.
Jupiler can 33 cl.
Leffe Blonde 33 cl.
Liedemans Kriek 8x25 cl.
Maes 50 cl.
Stella Artois 50 cl.
Stella Artois 25 cl.
Stella Artois can 33 cl.

**Breakfast Cereals**
Kellogg's Frosted Flakes
Kellogg’s Choco Pops
Kellogg’s Corn Flaes
NESTLÉ Cookie Crisp
NESTLÉ Cheerios Bio
NESTLÉ Fitness Chocolate Noir
NESTLÉ Nequisk Duo Chocolate

**Canned Vegs**
Bonduelle Pois Chiches 310 gr.
Bonduelle Petit Pois 280 gr.
Bonduelle Lentille
Elvea Cubes Tomates 800 gr.
Hak Pois Chiches 225 gr.
Hak Green Beans 680 gr.
Hak White Beans 360 gr.

**Cheese and butter**
Balade Beurre
Balade Crème 25 cl
Bertolli Margarile
Brie President
Campina Crème 25 cl.
Carlsbour Beurre
Galbani Mozzarella
Galbani Bufala
Leerdammer Original
Mme. Loik Nature
Planta Margarine
President Camembert
Solo Cuir et rotir kitchen
Vitelma essential omega

**Coffee**
Jacqmotte Cafe Moka
Douwe Egbers Moka
L'OR espresso capsule forza 104
L'OR Lungo Profondo
Nescafè Gold Dessert Instantanè
Nescafè Lungo capsule

**Toppings**
Barilla Sauce Napoletana
Barilla Sauce Bolognese
Barilla Pesto genovese
Bertolli Pesto ouge
Bertolli Sauce arrabbiata
MIRACOLI sauce pâtes italiano750g

**Flour and Sugar**
ANCO Farine Sluide
Imperial Farine Fermentant
Imperial Sucre Vanilla
Soubry Farine Patisserie
Soubry Farine pour pain blanc
Sucre de tirlemont fin

**Rice**
Bosto rice brown
Bosto basmati rice 1 kg
Bosto basmati rice 4x125 gr
Bosto thai rice 4x125 gr.
EBLY Bib 10' 4*125g
Uncle Ben's rice complet
Uncle Ben's rice long grain
Uncle Ben's rice basmati

**Pasta**
Barilla Farfalle
Barilla Penne rigate
Barilla Spaghetti
Soubry Macaroni coupè
Soubry Spaghetti fin avoine
Soubry Spaghetti fin al dente
Soubry Spaghetti integral

**Sauces**
Amora Mosterd 265g
Bister impériale moutarde 12,363
Calvé Mayonnaise aux Œufs 500 ml
DEVOS LEMMENS mayonnaise oeufs 750ml
DEVOS LEMMENS moutarde 450ml
DEVOS LEMMENS tomato ketchup 440ml
HEINZ (SERIOUSLY) GOOD mayonnaise 400ml
HEINZ Tomato Ketchup 875 ml
Heinz Ketchup 300ml
Hellmann’s Mayonaise 430ml
Kikkoman Soja 250ml
La William Mayonnaise 710 ml
MAILLE moutarde Fins Gourmets 340g
MAILLE moutarde L'Originale 380g
Zeisner Curry Ketchup 800ml

**Jam/Chocopasta**
BOERINNEKE fondant noir 400g
CÔTE D'OR pâte A TART NOIR DE NOIR
Materne gelee groseilles rouges 450g
Nutella 400g
Pur Nature confiture fraise 450g

**Snacks**
Delacre tea time 1kg
Kinder Delice
Lotus frangipane
Lotus speculoos 700 gr.
Lotus gaufre fourre vanille
Milka chocolate 100gr.
Oreo Original
Price ministar
Delacre cafè noir

**Soda**
Coca Cola Regular 1.5L
Coca Cola Zero 1.5L
Fanta Orange 1.5L
Lipton Thé Glacé 1.5L
Pepsi Regular Cola 1,5 L
Sprite 1.5L

**Milk**
Alpro Soya Milk
Campina Lait demi-écrémé PET
Campina Lait entier PET
Campina Lait frais
Fairebel Lait demi-écrémé
Fairebel lait entier
Joyvalle Lait AA Entier
Pur Nature Bio Lait Frais

**Water**
Bru 1.25 l
Evian 1 l
Perrier 1 l
SPA Reine
SPA Intense
Vittel 1.5 minerale

**Table A3**
**Average effect (all products): unweighted estimates**

| | **Regular Price (percent change)** | | | **Promo frequency (percent point)** | | | **Promo Price (percent change)** | | **Sale Price (percent change)** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 weeks | 3 months | 9 months | 2 weeks | 3 months | 9 months | 3 months | 9 months | 2 weeks | 3 months | 9 months |
| **POST 2 weeks** | **0.019***** | | | **-0.147***** | | | | | **0.096***** | | |
| | 0.001 | | | 0.001 | | | | | 0.003 | | |
| **POST to June** | | **0.012***** | **0.011***** | | **-0.060***** | **-0.058***** | **0.033***** | **0.030***** | | **0.026***** | **0.024***** |
| | | 0.001 | 0.001 | | 0.000 | 0.000 | 0.001 | 0.001 | | 0.001 | 0.001 |
| **July to Nov** | | | **0.006***** | | | **-0.003***** | | **0.014***** | | | **-0.001** |
| | | | 0.001 | | | 0.000 | | 0.001 | | | 0.001 |
| Observations | 1163302 | 2471477 | 4729061 | 1172992 | 2300206 | 4574923 | 688351 | 1508806 | 1163302 | 2471477 | 4729061 |
| Chain level | No | No | No | Yes | Yes | Yes | No | No | No | No | No |
| Store level | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ban included | Yes | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes |

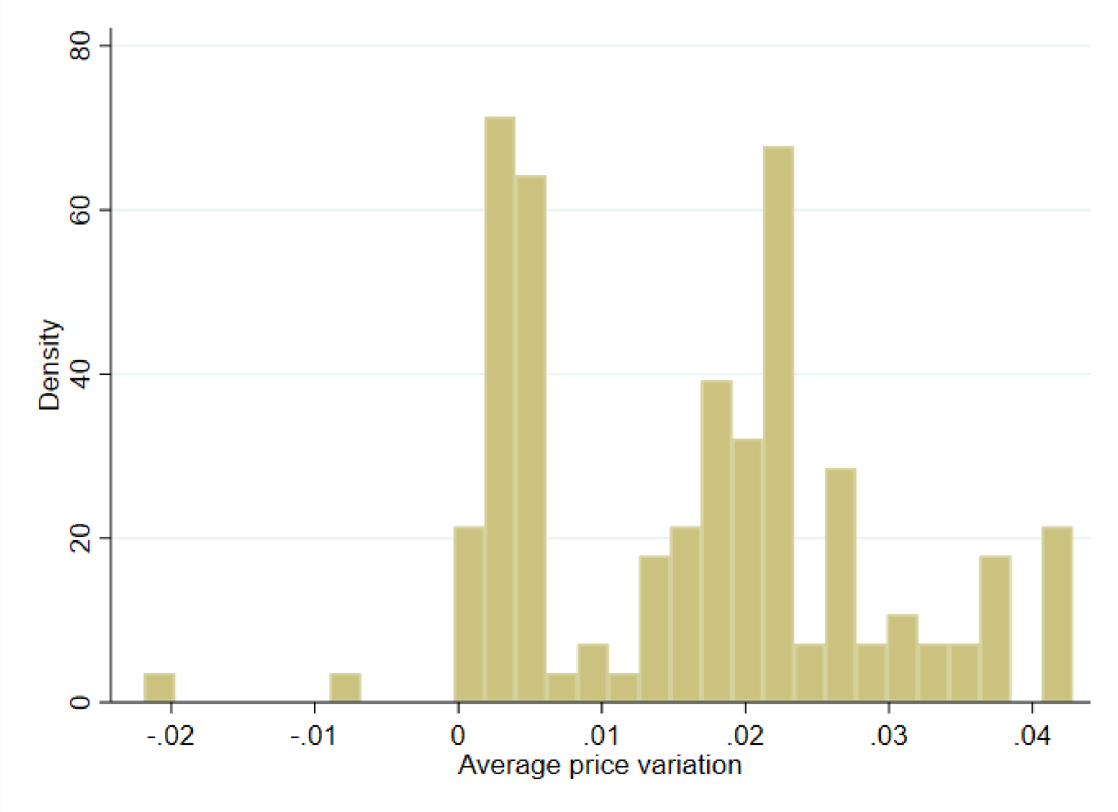
Note: Ban refers to the period between March,19 and April 3 in which a ban on discounts was imposed. These observations are removed for the 'promo price'. Standard errors clustered at a store level and presented in italics. Log-transformation of the dependent variable for regular price, promo price, and sale price. * p< 0.1, ** p<0.05, *** p<0.01.

## Table A4
## Average effect (all products) by retailer chain

| | Regular Price (percent change) | | | Promo frequency (percent point) | | | Promo Price (percent change) | | Sale Price (percent change) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2 weeks | 3 months | 9 months | 2 weeks | 3 months | 9 months | 3 months | 9 months | 2 weeks | 3 months | 9 months |
| **POST 2 weeks X Colruyt Lowest Prices** | **0.027*** ** | | | **-0.175*** ** | | | | | **0.122*** ** | | |
| | 0.001 | | | 0.001 | | | | | 0.002 | | |
| **POST 2 weeks X Collect & Go** | **0.022*** ** | | | **-0.167*** ** | | | | | **0.120*** ** | | |
| | 0.001 | | | 0.001 | | | | | 0.002 | | |
| **POST 2 weeks X Others** | **0.001** | | | **-0.003** | | | | | **0.002** | | |
| | 0.003 | | | 0.005 | | | | | 0.003 | | |
| **POST 2 weeks X Carrefour** | **0.009*** ** | | | **-0.106*** ** | | | | | **0.048*** ** | | |
| | 0.002 | | | 0.001 | | | | | 0.002 | | |
| **POST 2 weeks X Delhaize** | **0.007*** ** | | | **-0.077*** ** | | | | | **0.035*** ** | | |
| | 0.000 | | | 0.010 | | | | | 0.000 | | |
| **POST 2 weeks X Albert Hejin** | **0.000*** ** | | | **-0.071*** ** | | | | | **0.055*** ** | | |
| | 0.000 | | | 0.018 | | | | | 0.000 | | |
| **POST to June X Colruyt Lowest Prices** | | **0.016*** ** | **0.015*** ** | | **-0.062*** ** | **-0.061*** ** | **0.035*** ** | **0.031*** ** | | **0.031*** ** | **0.029*** ** |
| | | 0.001 | 0.001 | | 0.001 | 0.001 | 0.001 | 0.001 | | 0.001 | 0.001 |
| **POST to June X Collect & Go** | | **0.012*** ** | **0.010*** ** | | **-0.065*** ** | **-0.062*** ** | **0.036*** ** | **0.033*** ** | | **0.028*** ** | **0.026*** ** |
| | | 0.001 | 0.001 | | 0.001 | 0.001 | 0.001 | 0.001 | | 0.001 | 0.001 |
| **POST to June X Others** | | **0.005** ** | **0.006*** ** | | **0.004** | **0.001** | **-0.063*** ** | **-0.068*** ** | | **0.005** | **0.005** |
| | | 0.002 | 0.002 | | 0.003 | 0.003 | 0.000 | 0.004 | | 0.003 | 0.003 |
| **POST to June X Carrefour** | | **0.009*** ** | **0.009*** ** | | **-0.058*** ** | **-0.053*** ** | **0.004** | **0.004** | | **0.021*** ** | **0.019*** ** |
| | | 0.002 | 0.002 | | 0.001 | 0.001 | 0.002 | 0.003 | | 0.002 | 0.002 |
| **POST to June X Delhaize** | | **0.006*** ** | **0.006*** ** | | **-0.049*** ** | **-0.047*** ** | **0.010*** ** | **0.022*** ** | | **0.019*** ** | **0.019*** ** |
| | | 0.000 | 0.000 | | 0.006 | 0.006 | 0.000 | 0.000 | | 0.000 | 0.000 |
| **POST to June X Albert Hejin** | | **0.004*** ** | **0.004*** ** | | **-0.063*** ** | **-0.063*** ** | **0.025*** ** | **0.090*** ** | | **0.042*** ** | **0.042*** ** |
| | | 0.000 | 0.000 | | 0.010 | 0.010 | 0.000 | 0.000 | | 0.000 | 0.000 |
| **July to Nov X Colruyt Lowest Prices** | | | **0.002** | | | **0.009*** ** | **0.016*** ** | | | | **-0.010*** ** |
| | | | 0.002 | | | 0.001 | 0.002 | | | | 0.002 |
| **July to Nov X Collect & Go** | | | **0.007*** ** | | | **0.004*** ** | **0.014*** ** | | | | **-0.006*** ** |
| | | | 0.001 | | | 0.001 | 0.001 | | | | 0.001 |
| **July to Nov X Others** | | | **0.008*** ** | | | **0.017*** ** | **-0.071*** ** | | | | **0.006** |
| | | | 0.002 | | | 0.003 | 0.004 | | | | 0.004 |
| **July to Nov X Carrefour** | | | **0.008*** ** | | | **-0.024*** ** | **0.008*** ** | | | | **0.010*** ** |
| | | | 0.002 | | | 0.001 | 0.002 | | | | 0.002 |
| **July to Nov X Delhaize** | | | **0.009*** ** | | | **-0.011** ** | **0.021*** ** | | | | **0.012*** ** |
| | | | 0.000 | | | 0.005 | 0.000 | | | | 0.000 |
| **July to Nov X Albert Hejin** | | | **-0.007*** ** | | | **-0.032*** ** | **0.147*** ** | | | | **0.018*** ** |
| | | | 0.000 | | | 0.012 | 0.000 | | | | 0.000 |
| Observations | 1163302 | 2471477 | 4729061 | 1172992 | 2300206 | 4574923 | 688351 | 1508806 | 1163302 | 2471477 | 4729061 |
| Chain level | No | No | No | Yes | Yes | Yes | No | No | No | No | No |
| Store level | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ban included | Yes | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes |

Note: Ban refers to the period between March 19 and April 3 in which a ban on discounts was imposed. These observations are removed for the 'promo price'. Standard errors clustered at a store level. Log-transformation of the dependent variable for regular price, promo price, and sale price. * p< 0.1, ** p<0.05, *** p<0.01. *Others* include two smaller retail chains, such as Match and Intermarche

**Figure A1**
**Average price changes across LP pricing stores**

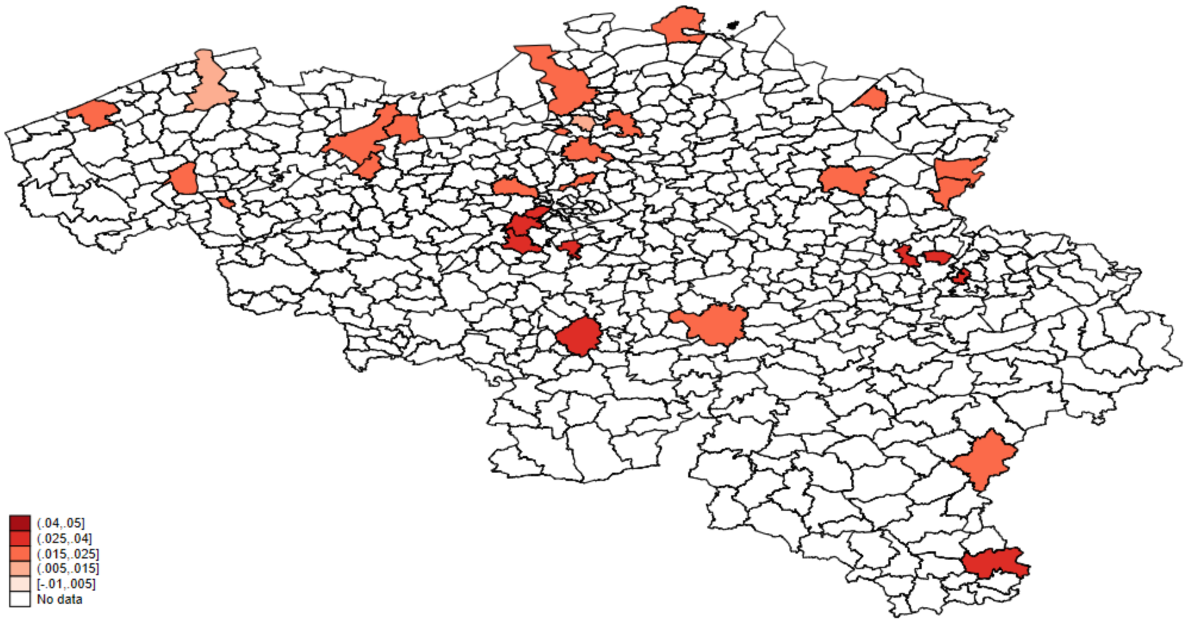



Average price variation following the announcement of the pandemic by WHO (March 11), one week before the implementation of the lockdown and up to March 31. 30 bins.

**Figure A2**
**Spatial heterogeneity in price variation for Carrefour**

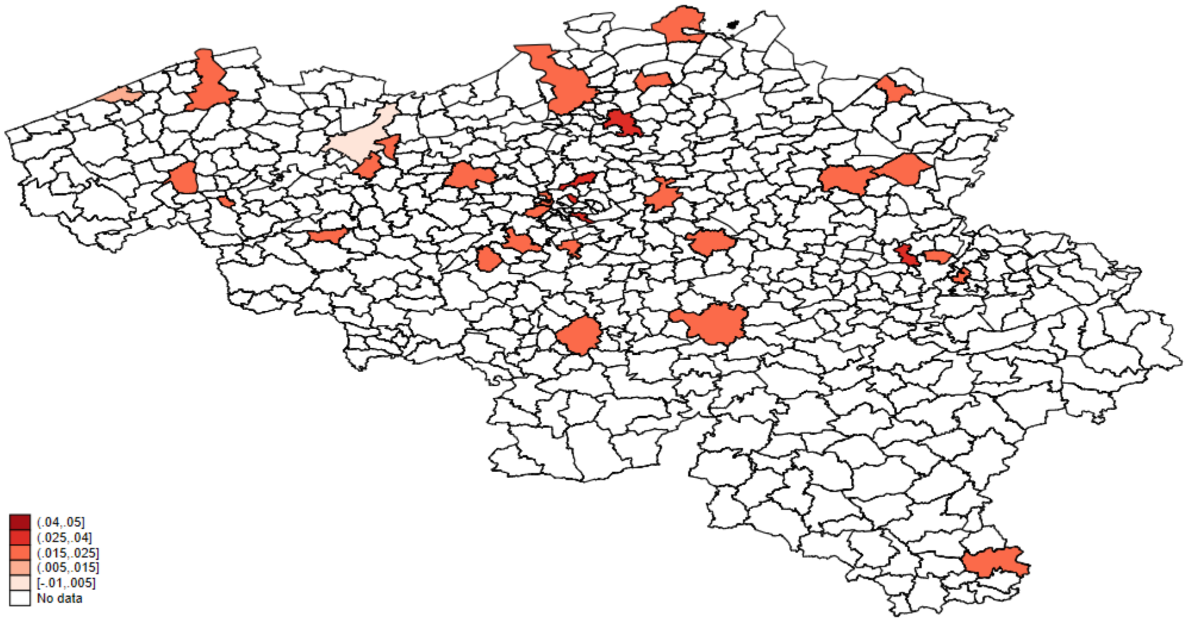

Average regular price variation for LP retailers in the period following the announcement of the pandemic by the WHO (March 11). The POST period includes the observation until March 31 (3 weeks). The dark red areas are those of Brussels.

**Figure A3**
**Spatial heterogeneity in price variation for Colruyt Lowest Price**




Average regular price variation for LP retailers in the period following the announcement of the pandemic by the WHO (March 11). The POST period includes the observation until March 31 (3 weeks). The red areas correspond to Brussels (and neighboring municipalities), Charleroi, Liege, and two municipalities bordering Luxembourg.

**Figure A4**
**Spatial heterogeneity in price variation for Colruyt - Collect & Go (Online)**




Average regular variation in price for Collect & Go (Online) stores in the period following the announcement of the pandemic by the WHO (March 11). The POST period includes the observation until March 31 (3 weeks). The red areas correspond to Brussels (and neighboring municipalities), Liege, and Arlon (a municipality bordering Luxembourg).

# ONLINE APPENDIX B

## B.1 Placebo Analysis

To assess the robustness of our results, we also provide descriptive evidence of what happened in 2019. As neither the pandemic nor a ban on discounts was present, we should not expect an effect similar to what was estimated and presented in Table 1. To this end, we suppose a shock occurring in the tenth week of 2019, which mimics the one that occurred in 2020. Table B1 summarizes this placebo analysis. As in the main model, we introduce weights based on the retail chains' market shares. Our findings show that for the same time period of the promotion ban, the average regular price and the average sale price did not significantly change in 2019, contrasting with the 1,7% and 8% average regular and sale price increases in 2020.

Extending the time window, we observe that the regular price decreased even more in 2019, with a stronger decrease in the second half of the year. The promotion price instead did not change significantly. These results suggest that our post-lockdown inflation in Table 1 cannot be attributed to price and promotion seasonality.

## B.2 Price Gap between UP and LP retailers

One key finding of our analysis is the presence of heterogeneity in the way different retail chains increased prices after the announcement of the pandemic by the WHO. However, the price variation we observed might hide significant pre-pandemic heterogeneity in the pricing policies. In this section, we compute the price gap between UP and LP retailers for every single product. We focus on those products always available in the retail chains identified and use Delhaize as a benchmark UP retailer and both Carrefour and CG as LP retailers. We denote $Dprice_{ikt}$ the price gap for product *i* between the regular price set by Delhaize at time *t* and the regular price set for the same product by a store *j* belonging to a retail chain *k={Carrefour, Collect & Go, Colruyt Lowest Prices}*at time *t*, such that

$$Dprice_{ikt} = price_{it}|Delhaize - price_{ijt}|k.$$

Interestingly, $Dprice_{ikt}$ is on average positive and equal to 17 eurocents. This implies that Delhaize has, on average, higher daily prices than its LP counterparts. Table B2 presents results for the evolution of the price gap during the Great Lockdown. The first panel presents the average price gap variation pooling together observations from Carrefour and CG. We find that the average price gap did not change significantly neither during the first two weeks of the lockdown nor within three months of the lockdown.

However, as shown by Figure 2, the average price variation was highly heterogeneous, with the largest price increase occurring in the Brussels Region. The second panel presents results in which the POST variable interacts with a dummy taking value equal to 1 for all Carrefour and CG stores located in the Brussels region. As a consequence of the large price increase in these stores, we find an average reduction of the price gap of 7.6 eurocent within two weeks of the lockdown and 5.2 eurocent within three months.

Finally, we decompose the price gap reduction by retail group. Consistently with the heterogeneous patterns identified in Figure 2, the large price gap reduction occurs for Carrefour, by approximately 10 eurocent against the 5 eurocent price gap reduction of Colruyt Group. This is due to the largest price increase of Carrefour stores in Brussels. Within three months of the lockdown, Carrefour prices in Brussels remained at a higher level, thus consolidating the reduction in the price gap vis-à-vis Delhaize (-8.9 eurocent). The price gap between CG stores in Brussels and Delhaize fully returned to the pre-pandemic level. A possible explanation is that after the first two weeks of the lockdown, the promotion ban was lifted, and as a consequence, CG started matching other stores' promotions and, as a result, increased its price gap vis-à-vis Delhaize.

These results suggest that LP retailers increased prices after the lockdown to a larger extent so that their prices converged to the higher prices set by the UP retailers.

### B.3 Pre-pandemic prices

In this section, we try to rationalize further the large spatial heterogeneity in price variation and verify possible mechanisms explaining such behaviors. One possible explanation could be that some local stores faced more inelastic demand than others, creating the conditions to further increase prices, especially in times in which domestic or foreign governments' restrictions might have generated panic buying (Keane and Neal 2021; O' Connell *et al.* 2020).

We study the pre-pandemic price level, using data between January 1, 2019 and March 10, 2020 and we identify with a dummy *HighVar* taking a value equal to 1 those stores with an average price increase post-pandemic of at least 3%.

Table B3 presents some interesting results. First, stores that increased their price beyond 3 % during the lockdown were the stores that in with the highest pre-pandemic prices. On average, the price level was approximately 2% higher in these stores. Second, there is a large heterogeneity across retail chains, with a price difference of approximately 3.4% for Colruyt Lowest Prices and 1% for Collect & Go and Carrefour. These results hint at the hypothesis we discussed, with the more reactive stores in the market being those charging higher prices and possibly facing less elastic demand.

**Table B1**
**Placebo analysis in 2019 (All products)**

| | Regular Price | | Promo Price | Sale Price | |
|---|---|---|---|---|---|
| | 2 weeks | 9 months | 9 months | 2 weeks | 9 months |
| **POST 2 weeks** | **-0.002** | | | **-0.008** | |
| | 0.001 | | | 0.003 | |
| **POST to June** | | **-0.003*****| **-0.001** | | **0.005***** |
| | | 0.001 | 0.004 | | 0.002 |
| **July to Nov** | | **-0.008*****| **-0.002** | | **-0.007***** |
| | | 0.002 | 0.004 | | 0.001 |
| Observations | 133860 | 544108 | 163577 | 133860 | 544108 |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes |
| Ban included | Yes | Yes | No | Yes | Yes |

Note: Ban refers to the period between March 19 and April 3 in which a ban on discounts was imposed. These observations are removed for the 'promo price'. Standard errors clustered at the store level. Log-transformation of the dependent variable for regular price, promo price, and sale price. * p< 0.1, ** p<0.05, *** p<0.01. We estimate the coefficient using WLS. The weights are calculated based on the retailer‘s market shares. Weights are set so that each UP retailer weights as its relative market share compared to other retailers. For LP retailers, the weights are set so that each store weights as a fraction of the retailer’s market share. The sum of these weights then equals the market share of the LP retailer relative to other chains.

## Table B2
## Regular Price Gap (in euro)

| | Carrefour and CG | | | | Carrefour | | CG | |
|---|---|---|---|---|---|---|---|---|
| | 2 weeks | 3 months | 2 weeks | 3 months | 2 weeks | 3 months | 2 weeks | 3 months |
| **POST 2 weeks** | **-0.006** | | | | | | | |
| | 0.005 | | | | | | | |
| **Brussels X POST 2 weeks** | | | **-0.076*** ** | | **-0.098*** ** | | **-0.050*** ** | |
| | | | 0.006 | | 0.009 | | 0.006 | |
| **POST to June** | | **-0.004** | | | | | | |
| | | 0.003 | | | | | | |
| **Brussels X POST to June** | | | | **-0.052*** ** | | **-0.089*** ** | | **-0.005** |
| | | | | 0.003 | | 0.004 | | 0.005 |
| Observations | 112801 | 2229148 | 112801 | 22148 | 40156 | 78908 | 72645 | 150240 |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Ban included | Yes | Yes | Yes | Yes | No | No | No | Yes |

Note: Brussels includes all stores within the Brussels Region. Standard errors clustered at a store level. Dependent variable (dprice). * p< 0.1, ** p<0.05, *** p<0.01.

**Table B3**
**Pre-pandemic price level**

| | **All** | **Carrefour** | **Colruyt Lowest Prices** | **Collect & Go** |
|---|---|---|---|---|
| **High-var** | **0.021*****<br>0.004 | **0.008*****<br>0.002 | **0.034*****<br>0.006 | **0.010****<br>0.004 |
| Observations | 653048 | 222165 | 191549 | 239334 |
| ProductXRetailerXStore FE | Yes | Yes | Yes | Yes |

Note: HighVar identifies those stores with an average price increase post-pandemic of 3%. The analysis is conducted for the period January 1, 2019-March 10, 2020. Log-transformation of the dependent variable (regular price). Standard errors clustered at a store level. * p< 0.1, ** p<0.05, *** p<0.01.