Price-setting behaviour in Belgium: New evidence from micro-level CPI data

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Introduction

In recent decades, national statistical agencies have increasingly been providing researchers with the micro-level data on consumer and producer prices that they rely on for compiling official statistics. This trend has spawned numerous empirical studies seeking to come up with evidence on price adjustment and explain inflation dynamics. Despite the significant progress that has now been made and the broad coverage of countries examined[1], the bulk of the existing literature covers the 1990s and early 2000s, with pertinent evidence as of the more recent period being scarce[2]. Importantly, while the 1990s and early 2000s span the period characterised by robust GDP growth and inflation rates close to target levels (i.e. the "Great Moderation") in most advanced economies, subsequent years have been marked by the financial crisis of 2007 and the ensuing global GDP and trade collapse, the 2010-2012 euro area sovereign debt crisis with its regional and global side effects and the low inflation environment in the euro area as of 2013. As a result, these events have rendered even more compelling the need of policy-makers and academics alike to understand how micro-level prices have been set in recent years and inform monetary policy accordingly.

Our main objective in this article is to contribute on this front. Exploiting a new release of micro-level CPI (Consumer Price Index) data of monthly frequency for Belgium over the period from January 2007 to December 2015, we provide evidence on how frequently prices adjust, how large these adjustments are, and the time- and state-dependent aspects of these adjustments. The patterns and trends that we identify are summarised in six stylised facts and are broadly consistent with those documented in the existing literature.

First, firms change their prices quite frequently, that is, every five to seven months. These numbers are smaller compared to what has been reported in the literature for Belgium and the euro area. Second, downward price adjustments are not uncommon (even excluding seasonal sales): they account for roughly one-third of total price changes and are comparable to what has been reported previously for Belgium, other euro area countries and the US. Third, price increases and decreases are relatively sizeable, of an average magnitude of roughly 12 % each, and small price changes (i.e. of less than 1 % or 2 %) are relatively few. Both the magnitudes of price changes and the scarcity of small price changes are greater than what has been reported in earlier studies. These facts, along with the more frequent price changes, possibly reflect the more volatile macroeconomic

1 See, among others, Bils and Klenow (2004), Klenow and Kryvtsov (2008), Nakamura and Steinsson, (2008), Midrigan (2010) and Midrigan and Kehoe (2015) for the US; ECB Inflation Persistence Network (IPN) studies for individual euro area countries and the euro area (Dhyne *et al.*, 2006; Alvarez *et al.*, 2006; Fabiani *et al.*, 2006; Vermeulen *et al.*, 2012); Gagnon (2009) for Mexico; Berardi *et al.* (2015) for France; and Wulfsberg (2016) for Norway. For a comprehensive review of the early literature, see Klenow and Malin (2010).

2 See, for instance, Berardi *et al.* (2015) who use monthly micro-level CPI data for France over the period April 2003 - April 2011.

environment from 2007 to 2015 compared to previous years. Fourth, the frequency of price changes has a time-dependent feature (Taylor, 1980; Calvo, 1983). Price rises occur more often in January, February, April and October, while price cuts occur more often in April, July and October.

Fifth, heterogeneity in all these dimensions across product categories is salient. For instance, the prices of unprocessed and processed food products change roughly every one or two quarters, prices of non-energy industrial goods change every year, while services prices change every two years on average. In terms of size, price changes for unprocessed food products and non-energy industrial goods are relatively large (16 % to 18 % and 10 % to 11 %), while price changes for services and processed food products are relatively small (roughly 7 %).

Sixth, during the great financial crisis and its aftermath (2007-2009) and the low inflation environment in the euro area (as of 2013), there was a declining trend in the frequency of price rises in Belgium, a growing trend in the frequency of price cuts, while price falls were more sizeable than price rises. These patterns and trends may be suggestive of price changes being determined by macroeconomic and financial shocks highlighting their state-dependent feature (Cecchetti, 1985; Klenow and Kryvtsov, 2008; Dixon *et al.*, 2020).

1. Data

In this section, we describe the micro-level CPI dataset that we use in the empirical analysis.

The dataset has been made available to the National Bank of Belgium (NBB) by the Belgian Statistical Office (Statbel), which collects data on consumer prices for calculating the official National and Harmonised Index of Consumer Prices for Belgium. The dataset covers the period from January 2007 to December 2017 at a monthly frequency. Data collection over the period 2007-2015 was mostly made by regular visits of pollsters to retail shops, except in the case of cars where prices were collected from catalogues. By contrast, as of 2016, the Statistical Office has relied primarily on scanner data for a wide range of products sold at supermarkets in Belgium[1]. As these data could not be released to the NBB for confidentiality reasons, the dataset has a limited product coverage from 2016 onwards. For this reason, we drop the last two years and consider only the period between January 2007 and December 2015 in our analysis.

For each price quote available in the dataset except for those for cars, we observe the date (month and year), the unique product identifier and its corresponding description as well as the corresponding 6-digit COICOP[2], the measurement unit, the unique identifier and address of the retail shop, the unique identifier and name of the Belgian city or town where the retail shop is located, and flags indicating a promotion, unavailability of the product for at least a month, and imputed price[3]. Except for services, the product description is a detailed text enabling us to identify different brands of products after dealing with small discrepancies across text descriptions[4]. We mostly identify brands by the name of the brand included in the text (e.g. Côte d'Or, Jacques, etc. for chocolate products). When additional product characteristics are included, we take these into consideration in order to define individual products. In other words, we treat as different items two chocolates that have the same brand name (e.g. Côte d'Or) but different characteristics (e.g. milk chocolate, dark chocolate). In order to calculate unit values, upon which we rely throughout the analysis, we first homogenise measurement units whenever necessary (e.g. from ml and cl to litre, from grams to kilogram). As regards cars, in addition to

1 Covering as much as 22 % of the consumption basket in 2016.

2 The Classification of Individual Consumption According to Purpose (COICOP) is the international reference classification of household expenditure on homogeneous categories of goods and services. The COICOP codes available in the dataset, along with the corresponding product description and average weight over 2007–2015 are shown in table A1.

3 For instance, the price collector may impute a missing price and this is flagged in the dataset.

4 For a few observations, applying mostly to unprocessed food products, the text description is missing. We can, however, uniquely identify these products from the combination of their identifier and the identifier of the retail shop.

the date (month and year) of each price quote, we observe the name of the manufacturer, the model and the version, the number of doors, the engine type, the motor type and the number of gears, the combination of which allows us to identify an individual car. In this way, we ensure consistency in the definition of an individual product between cars and the rest of the products (e.g. chocolates).

We group each product available in the categories of unprocessed food, processed food, non-energy industrial goods, or services, based on its unique identifier and the relevant classification established by Eurostat[1]. Information on energy sector products is not available in the dataset. We also account for the weight of each product in the consumption basket by using additional information on its share in household expenditure. This information originates from the Household Budget Survey (HBS) and is made available to us by the Statistical Office at the 6-digit COICOP level. The weights of most products vary by month or by year, while the weights of seasonal products (e.g. winter jackets) are non-zero only in certain calendar months, when expenditure on such products is mostly recorded.

We calculate price trajectories of individual products based on the combination of brands, unique retail shop identifiers and year-month pairs[2]. That is, we consider that the brand of a product sold at a certain shop and location in a given month and year has a different price trajectory from the same brand sold in the same month and year at another shop of the same or another location[3]. After eliminating a small fraction of duplicates and the observations corresponding to 2016 and 2017, we are left with 8 794 966 observations. In order to account for outliers while calculating monthly price changes, we apply the methodology of Klenow and Kryvtsov (2008). We consider a price change as "unusual" if the new price is at least five times larger or smaller than the old price. Factor 5 indicates that there are 267 price trajectories in which outliers are detected. Dropping the factor 5 outliers results in a loss of 4 051 observations.

Relying on the flag for imputed prices, we identify that such cases correspond to 25 950 observations (0.3 % of the total) and eliminate them. The flag for promotions indicates that these correspond to 164 323 price quotes (1.87 % of the total). For the majority of these observations (84.7 %), we do observe a drop in price. For small fractions of these, however, we observe no price changes (6.12 %) or price rises (4.96 %). After dropping the observations corresponding to the last two cases[4], we lose 10 057 and 8 156 observations, respectively. In contrast to promotions, data limitations do not allow us to account for seasonal sales that take place in Belgium in January and July of each year. Relatedly, we identify 171 408 price quotes in January and July that have been assigned the values of the respective preceding month (i.e. December and June)[5]. To avoid any bias in our analysis, we drop these other imputed prices from the sample. Regarding product replacements, these are identified by the flag indicating whether the product has become unavailable for at least a month. There are 75 084 such cases (0.87 % of the total). For the majority of these (66 481), no price change is observed, while price increases are observed in only 185 cases. Although a fall in prices is observed in the remaining 7 084 cases, we consider as valid only 182 of these as the new price for the rest drops to zero.

After the data cleaning, the dataset that we rely on in the empirical analysis comprises 8 575 344 observations. Price quotes for unprocessed and processed food account for relatively high fractions of the total number of observations (35.6 % and 42.3 %, respectively), price quotes for non-energy industrial goods and services account for relatively low fractions of the total number of observations (14.2 % and 7.9 %, respectively), while there are no price quotes for energy products (columns 2 and 3 of table A2). In addition, comparisons of the average weights of product categories in our dataset over the period 2007-2015 (column 4 of table A2) with the corresponding weights in the aggregate CPI (column 5 of the same table) reveal that although we make use

1 This classification groups COICOP codes into "special aggregates" such as those considered in this article.

2 For cars, we use only brand-year-month triplets.

3 As each retail shop corresponds to a single city or town, it is sufficient to consider only the retail shop identifiers in conjunction with the brands of products.

4 As these might have been mistakenly flagged as promotions by the price collectors.

5 These imputed price quotes correspond to non-energy industrial goods (primarily clothes).

of all the information used by the Statistical Office for the calculation of official CPI statistics on unprocessed food (12.5 %) and processed food (8.3 %) products, we use rather limited information on non-energy industrial goods (16.2 % versus 30.7 %) and especially, on services (9.9 % versus 36.2 %)[1].

Conceptually, the frequency of price adjustments shows the fraction of retailers that change the price of a certain item that they sell. We thus calculate it as the ratio of the total number of monthly price changes of a given brand-shop pair (i.e. of an individual product) in the respective total number of price quotes. Conditional on a price change made by a retailer for a certain item, the size of the price adjustment shows the magnitude of the change. Hence, we calculate it as the log difference of prices between two consecutive months. At the aggregate, the product of the frequency of price adjustments (extensive margin) and the size of price adjustments (intensive margin) yield the inflation rate.

2. Evidence on price adjustment

In this section, we present cross-sectional and time-series evidence on the frequency and size of price adjustments.

2.1 How frequently do prices adjust?

In order to examine how often retailers change their prices, we start off with the analysis on the frequency of price adjustments in the cross section. Table 1 displays the mean and median frequencies of price changes, the same statistics considering the direction of price changes (i.e. up or down), the fraction of price reductions, and the mean and median implied durations. In Panel A, we produce the statistics on the sample that includes promotions and product replacements, while in Panel B, we produce the statistics on the sample that excludes both promotions and product replacements.

Panel A reveals that the mean and median frequencies of price changes are 18.3 % and 14.7 %, respectively (column 1). These frequencies work out at 5 and 6.3 months during which prices remain unchanged (column 5). Although price decreases are less frequent than increases, these are not uncommon. The corresponding mean and median frequencies are 7.7 % and 5.5 % (column 3), implying that price decreases account for 42 % and 37.2 %, respectively, of price changes (column 4). Panel B exhibits the same patterns. However, primarily due to promotions being excluded, the mean and median frequencies of price changes and the fraction of price decreases are smaller, and in turn, the mean and median implied durations are larger. In particular, the mean and median frequencies of price changes are 16.8 % and 13.1 % (column 1), which work out at 5.4 and 7.1 months of unchanged prices (column 5). The mean and median frequencies of price decreases are 6.2 % and 3.6 % (column 3), implying that 37.2 % and 27.2 %, respectively, of price changes correspond to decreases (column 4).[2]

The frequencies given in table 1 are almost identical to or higher than those reported by studies covering Belgium and the euro area in the 1990s and early 2000s. Using micro-level CPI data on a common sample of 50 goods and services for individual euro area countries[3] over the period from January 1996 to January 2001, Dhyne *et al.* (2006) report a mean frequency of price changes in the euro area of 15.1 %, a mean implied

1 Data cleaning does not alter the composition of the raw dataset, as we observe very similar patterns to those in table A2 when we produce the statistics before removing observations for data cleaning purposes. These statistics are available upon request.

2 Including promotions and excluding product replacements produces very similar statistics to those in Panel A, while excluding promotions and including product replacements produces very similar statistics to those in Panel B. These tables are available upon request.

3 The euro area countries included in the analysis are Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Portugal, and Spain.

Table 1

Frequency of price changes

	Frequency (%)			Fraction (%)	Implied Duration (months)
	Changes	Increases	Decreases	Decreases	–1/ln (1 – Freq)
Panel A: Incl. promotions and product replacements					
Mean	18.3	10.5	7.7	42	5
Median	14.7	9.7	5.5	37.2	6.3
Panel B: Excl. promotions and product replacements					
Mean	16.8	10.5	6.2	37.2	5.4
Median	13.1	9.7	3.6	27.2	7.1

Notes: Mean and median frequencies are calculated in two steps. First, we calculate the *unweighted* mean of the frequency of price changes across year-month pairs by retailer-brand pair. Then, we calculate the *weighted* mean or median across retailer-brand pairs using the 6-digit COICOP weights. The fraction of price decreases is the ratio of the mean or median frequency of price decreases to the corresponding frequency of price changes. Frequencies of price changes and the fraction of price decreases are in percentages. The mean and median implied durations are calculated as –1/ln (1 – Freq), where Freq is the mean and the median frequency of price changes, respectively (Nakamura and Steinsson, 2008). Implied durations represent the number of months during which prices remain unchanged. Calculating the mean (median) implied duration of Panels A and B as the inverse of the mean (median) frequency of price changes, 1/Freq, yields 5.5 and 6 (6.8 and 7.6) months.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

duration of 13 months, and a median implied duration of 10.6 months[1]. The mean frequency of price changes that they report for Belgium is equal to 17.6 %. Berardi *et al.* (2015) use micro-level CPI data for France covering a period that overlaps with ours (April 2003 - April 2011) and report mean frequencies of price changes that range from 15 % (excluding promotions-seasonal sales and product replacements) to 20.1 % (including promotions-seasonal sales and product replacements)[2].

For the US, Bils and Klenow (2004) use micro-level CPI data from the US Bureau of Labor Statistics (BLS) for the period 1995-1997 and find a mean frequency of price changes of 26.1 %. Relying on the same data source but covering a longer time span (1988-2004), Klenow and Kryvtsov (2008) report a mean (median) frequency of regular (i.e. non-sales) price changes of 29.9 % (13.9 %) and a mean (median) implied duration of 8.6 (7.2) months. Nakamura and Steinsson (2008) also rely on the BLS CPI data and conduct their analysis on two different sample periods: 1988-1997 and 1998-2005. They find that the median frequency of regular price changes is roughly half of what it is when sales are considered as price changes (9 % - 12 % compared with 19 - 20 % when product replacements are excluded; 11 % - 13 % compared with 21 - 22 % when product replacements are included). For regular prices, the corresponding median implied durations range between 8 and 11 months (when product replacements are excluded) and between 7 and 9 months (when product replacements are included).

The fractions of price reductions are comparable to those reported in early and more recent studies: 42 % for the euro area (Dhyne *et al.*, 2006), roughly 35 % for the US (Nakamura and Steinsson, 2008), 36.5 % (excluding

1 In addition to the different period and product composition examined with respect to our study, the authors calculate the weighted mean and median implied durations slightly differently from us. In particular, rather than plugging the weighted mean or median frequency of price changes in the formula of implied duration (Nakamura and Steinsson, 2008), they first calculate the implied duration at the product level, and then they calculate the weighted mean and median implied durations across products using relevant product weights.

2 In this paper, sales prices are defined as prices corresponding to either seasonal sales or temporary promotional discounts. Product replacements correspond to cases where the product is no longer available in a certain retail store, the retail store ceases to exist, or the retail store or product is disregarded by the Statistical Office so that the sample includes items that are representative of the consumption pattern.

promotions-seasonal sales and product replacements) and 39.8 % (including promotions-seasonal sales and product replacements) for France (Berardi *et al.*, 2015).

The statistics in table 1 are produced on samples that include all available products. In order to examine possible differences across product categories, we produce in table 2 the same statistics for unprocessed food, processed food, non-energy industrial goods, and services[1]. For the scope of this exercise, we use the sample without promotions and product replacements which we consider as the benchmark. Heterogeneity in the frequency of price adjustments and the implied duration across the four product categories is salient.

Prices of unprocessed and processed food products change more frequently than prices of non-energy industrial goods and services. Also, the mean frequencies of the first two product categories are above the sample mean, while the mean frequencies of the other two product categories are below the sample mean (27.4 %, 19 %, 7.2 % and 3.7 % compared with 16.8 %). Comparisons of the median frequencies reveal the same patterns. In terms of duration, prices of unprocessed and processed food products change every 3.1 to 5.7 and 4.4 to 4.7 months, respectively, while prices of non-energy industrial goods change every 13.2 to 13.4 months and prices of services change every 26.5 to 28.9 months. Also, (downward) price rigidity for the first three product categories is comparable to that on the whole sample, as indicated by comparisons of the fractions of price decreases (40.4 %, 36.8 %, 30.7 % against 37.2 % based on the mean frequencies). By contrast, the prices of services are relatively rigid, as decreases account for only 12 % or 9.3 % of the identified price changes, based on mean or median frequencies[2].

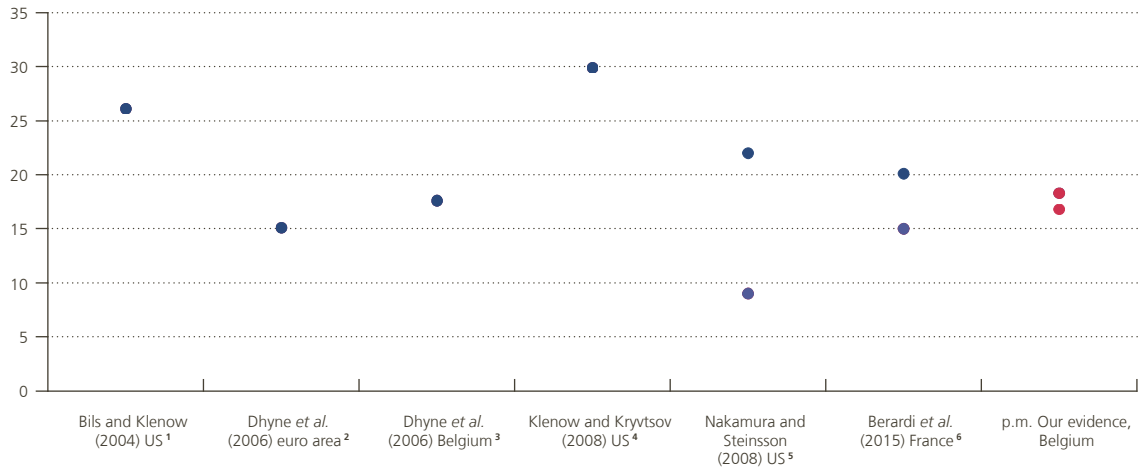
1 As mentioned in the data section, the dataset does not include prices on energy products and thus, the energy sector is not included in the analysis.

2 Using the same statistics from table 2 on the sample that includes promotions and product replacements naturally results in higher mean and median frequencies and lower mean and median implied durations within each product category, but the comparisons across product categories lead to the same conclusions (table B1).

Chart 1

Key findings of related empirical studies

(frequency of price changes in %)



1 Mean frequency, 1995-1997, 70 % of the CPI covered.

2 Mean frequency, January 1996 - January 2001, common sample of 50 products.

3 Mean frequency, January 1996 - January 2001, common sample of 50 products.

4 Mean frequency, 1988-2004, 70 % of the CPI covered.

5 Median frequency, 1988-1997 and 1998-2005, 70 % of the CPI covered : lowest point is excluding sales and product replacements, highest point is including sales and product replacements.

6 Mean frequency, April 2003 - April 2011, 65 % of the CPI covered : lowest point is excluding sales and product replacements, highest point is including sales and product replacements.

Table 2

Frequency of price changes by product category, excluding promotions and product replacements

	Frequency (%)			Fraction (%)	Implied Duration (months)
	Changes	Increases	Decreases	Decreases	–1/ln (1 – Freq)
Panel A: Unprocessed food					
Mean	27.4	16.3	11.1	40.4	3.1
Median	16	11.8	4.7	29.5	5.7
Panel B: Processed food					
Mean	19	12	7	36.8	4.7
Median	20.2	12.8	7.6	37.7	4.4
Panel C: Non-energy industrial goods					
Mean	7.2	5	2.2	30.7	13.4
Median	7.3	4.8	1.8	24.7	13.2
Panel D: Services					
Mean	3.7	3.3	0.4	12	26.5
Median	3.4	3.1	0.3	9.3	28.9

Notes: Mean and median frequencies are calculated in two steps. First, we calculate the unweighted mean of the frequency of price changes across year-month pairs by retailer-brand pair and product category. Then, we calculate the weighted mean or median across retailer-brand pairs by product category using the 6-digit COICOP weights. The fraction of price decreases and implied duration are calculated as in table 1. Frequencies of price changes and the fraction of price decreases are in percentages. Implied durations represent the number of months during which prices remain unchanged. Calculating the mean (median) implied duration of Panels A, B, C and D as the inverse of the mean (median) frequency of price changes, 1/Freq, yields 3.6, 5.3, 14 and 27 (6.2, 4.9, 13.4 and 29.4) months.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007-December 2015.

The literature has rationalised price rigidity by putting forward reasons that vary from explicit and implicit contracts with customers for the development of strong ties, to cost-based pricing, to coordination failure (Fabiani *et al.*, 2006). In relation to cost-based pricing, as labour costs account for a relatively high share of total production costs in the services sector, downward price rigidity is also expected to be relatively high. Another possible reason is the composition of services included in the dataset. In fact, the bulk of services are accounted for by restaurants and cafés where price changes are subject to menu costs, as well as by hairdressers and housing-related services (e.g. painting, electricity work, plumbing) where prices change infrequently. By contrast, services whose prices change more frequently (e.g. telecommunications, holidays, cultural events) are not included in the dataset.

The patterns that appear in table 2 are consistent with those documented in the literature. Among the four product categories, Dhyne *et al.* (2006) show that the frequency of price changes is the highest for unprocessed food products, smaller for processed food products, even smaller for non-energy industrial goods, while it is the smallest for services (31.5 %, 19.1 %, 5.9 % and 3 % for Belgium). This is also the case for the other individual euro area countries examined (Austria, Germany, Finland, France, Italy, Luxembourg, the Netherlands, Portugal, Spain). The corresponding figures for the US are 47.7 %, 27.1 %, 22.4 % and 15 % (Bils and Klenow, 2004). For the same country, Nakamura and Steinsson (2008) report ranges of frequencies from 25 % to 39 % (unprocessed food), 10.5 % to 25.9 % (processed food), and 6.1 % to 9.1 % (services), depending on whether sales and product replacements are excluded or not and whether the mean or median is calculated.

2.2 How large are price adjustments?

In this section, we present the cross-sectional evidence on the size of price adjustments. Table 3 displays the mean and median size of price changes, the values of the 25th and 75th percentiles (P25 and P75), and the fraction of prices that change by less than 1 % and 2 % in the total number of price changes. The same statistics are also produced when considering the direction of price changes (i.e. increase or decrease).

When promotions and product replacements are included (Panel A), we find that prices change, on average, by 13.2 % (column 1) in absolute value. The respective P25, median (P50) and P75 values are equal to 7.3 %, 10.9 % and 16.9 % (columns 2-4). Considering the direction of price changes, we find that decreases are more sizeable than increases: the mean size of price increases is equal to 12 %, while the mean size of price decreases is equal to 14.7 %. This also holds in the other segments of the distribution: 7.1 % compared with 8.3 % (P25), 9.8 % compared with 13.3 % (median), and 14.8 % compared with are 19.3 % (P75). Regarding small price changes, we find that these are relatively few. In particular, the prices that change by less than 1 % and 2 % account for 6.3 % and 13.8 % of the total number of price changes. Similarly, the prices that increase (decrease) by less than 1 % and 2 % account for only 5.8 % (6.9 %) and 13.6 (14 %), respectively, of the total number of price changes.

Due to the smaller price reductions when promotions and product replacements are excluded, price increases are, on average, almost as big as price decreases (12 % against 12.3 %), larger at the lower end (P25) and middle (median) of the distribution (7.1 % compared with 5.9 % and 9.8 % against 8.7 %), and smaller only at the higher end (P75) of the distribution (14.8 % compared with 17.1 %)[1]. Although the fractions of prices that fall by less than 1 % and 2 % rise to 7.9 % and 16 %, they still suggest that small price cuts are relatively few.

The magnitudes of price changes that we observe are mostly larger compared to those reported in the literature. Using monthly CPI data for 1996-2001, Dhyne *et al.* (2006) report a mean size of price increases equal to 8.2 % and a mean size of price decreases equal to 10 %. According to Berardi *et al* (2015) who

1 Including promotions and excluding product replacements produces very similar statistics to those in Panel A, while excluding promotions and including product replacements produces very similar statistics to those in Panel B. These tables are available upon request.

Table 3

Size of price changes

	Size (log price difference)				Fraction (%)	
	Mean	Median	P25	P75	Size ≤ 1 %	Size ≤ 2 %
Panel A: Incl. promotions and product replacements						
Changes	0.132	0.109	0.073	0.169	6.3	13.8
Increases	0.12	0.098	0.071	0.148	5.8	13.6
Decreases	0.147	0.133	0.083	0.193	6.9	14
Panel B: Excl. promotions and product replacements						
Changes	0.121	0.096	0.068	0.15	6.6	14.6
Increases	0.12	0.098	0.071	0.148	5.8	13.6
Decreases	0.123	0.087	0.059	0.171	7.9	16

Notes: The size of price changes is the log price difference in two consecutive months. The statistics for the size of price changes are calculated in two steps. First, we calculate the unweighted mean of the size of price changes across year-month pairs by retailer-brand pair. Then, we calculate the weighted mean, median, P25 or P75 value across retailer-brand pairs using the 6-digit COICOP weights. The fractions of small price changes (less than 1 % and 2 %) are in percentages.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

use CPI data for France, the mean and median sizes of price increases are equal to 7.9 % and 3.7 % when promotions and seasonal sales are excluded, and 12.8 % and 4.3 %, when these are included. The respective figures for price decreases are 7.8 % and 4.4 % (promotions and seasonal sales excluded) and 11.5 % and 6.1 % (promotions and seasonal sales included). According to Nakamura and Steinsson (2008) who use CPI data for the US, the mean and median sizes of price increases are 9.2 % and 8 % (sales excluded) and 14.9 % and 12.3 % (sales included); and the mean and median sizes of price decreases are 12 % and 10.7 % (sales excluded) and 18.5 % and 15.3 % (sales included). In terms of the fraction of small changes reported in this article, these are smaller compared to what has been reported in earlier studies. According to Berardi *et al.* 2015), price changes in France that are smaller than 1 % (2 %) account for 13 % (27.4 %) and 11.2 % (23.7 %) of total price changes when promotions and seasonal sales are excluded and included, respectively.

Next, our goal is to document possible differences in the size of price adjustments across the four product categories examined. To this end, we re-produce in table 4 the statistics from table 3 by product category for the benchmark case. The salient heterogeneity in the size of price adjustments across the four panels is easily discernible. According to the mean values and the values of the other parts of the size distribution (P25, median, P75), changes in the price of unprocessed food products, including when considering the direction of these, are bigger compared to the whole sample. This is most likely explained by the relatively short shelf life of such products and their supply being subject to higher uncertainty (e.g. weather conditions, logistics). By contrast, price changes for processed food products, non-energy industrial goods and services are smaller, except for the price reductions for non-energy industrial goods. The latter may be explained by electronic products (e.g. game consoles), furniture, motorcycles and bicycles. Prices of unprocessed food change, on average,

Table 4

Size of price changes by product category, excluding promotions and product replacements

	Size (log price difference)				Fraction (%)	
	Mean	Median	P25	P75	Size ≤ 1 %	Size ≤ 2 %
Panel A: Unprocessed food						
Changes	0.177	0.164	0.112	0.235	3.9	8.4
Increases	0.179	0.149	0.116	0.24	3.7	8.4
Decreases	0.175	0.171	0.099	0.238	4	8.3
Panel B: Processed food						
Changes	0.071	0.069	0.058	0.082	10.5	23.6
Increases	0.076	0.076	0.063	0.09	8.3	20.6
Decreases	0.062	0.058	0.049	0.073	14.1	28.7
Panel C: Non-energy industrial goods						
Changes	0.096	0.108	0.019	0.135	6.8	10.6
Increases	0.079	0.087	0.018	0.123	7	11.5
Decreases	0.134	0.133	0.109	0.166	6.6	9.2
Panel D: Services						
Changes	0.073	0.073	0.062	0.078	4.1	11.6
Increases	0.072	0.072	0.062	0.081	3.7	11.3
Decreases	0.082	0.078	0.068	0.094	7.3	14

Notes: The size of price changes is the log price difference in two consecutive months. The statistics for the size of price changes are calculated in two steps. First, we calculate the unweighted mean of the size of price changes across year-month pairs by retailer-brand pair and product category. Then, we calculate the weighted mean, median, P25 or P75 value across retailer-brand pairs by product category using the 6-digit COICOP weights. The fractions of small price changes (less than 1 % and 2 %) are in percentages.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

by 17.7 % (column 1 of Panel A), while prices in the other categories change, on average, by 7.1 %, 9.6 % and 7.3 % (column 1 of Panels B to D).

Differences in the degree of scarcity of relatively small price changes are also evident. In particular, the scarcity of small price changes is greater for unprocessed food products and non-energy industrial goods compared to the whole sample. This is also the case for services, despite the smaller price adjustments observed for this category. By contrast, identifying relatively small price changes for processed food products is less uncommon compared to the whole sample and the other product categories. Depending on the threshold considered and the direction of price changes, such occurrences account for 8.3 % to 28.7 % of the total number of changes. Comparisons between the sizes of price increases and decreases within each product category reveal that while price increases are more sizeable than price decreases for unprocessed and processed food products, the reverse holds true for non-energy industrial goods and services[1].

Similar heterogeneity across product categories to that observed in table 4 has also been documented in the existing literature. Considering consumer prices in the euro area from 1996 to 2001, Dhyne *et al.* (2006) find that the mean sizes of increases and decreases are the highest for unprocessed food products (14.7 % and 16.3 %), followed by non-energy industrial goods (9.4 % and 11.4 %), services (7.3 % and 9.7 %) and processed food products (6.9 % and 8.1 %). A slightly different pattern is observed for US consumer prices (Nakamura and Steinsson, 2008). The median size of regular price increases is the highest for unprocessed food products (13.9 %), followed by processed food products (11.5 %) and services (6.5 %). The median size of regular price decreases is the highest for processed food products (17.6 %), followed by unprocessed food products (15 %) and services (9.5 %).

2.3 Are price adjustments time- and state-dependent?

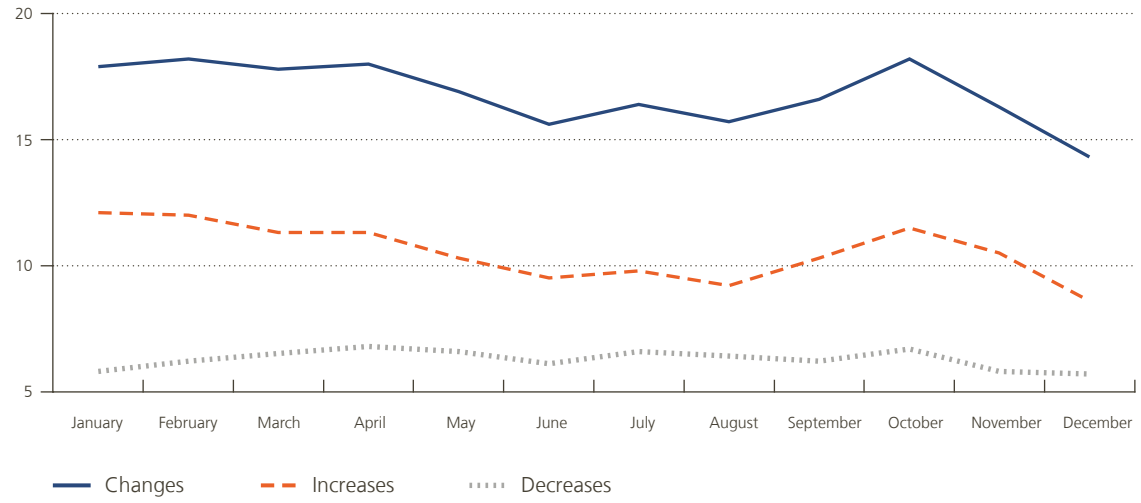
Having examined the cross-sectional evidence on the frequency and size of price adjustments, we now proceed to the analysis of the relevant time-series evidence. Our starting point is to show suggestive evidence on the time-dependent aspect of price adjustments (Taylor, 1980; Calvo, 1983). Relying on the benchmark sample (i.e. promotions and product replacements excluded), chart 2 portrays the evolution of the mean frequencies of price changes (solid line), increases (dashed line) and decreases (dotted line) across months. The lines exhibit seasonal trends: price increases occur more often in January, February, April and October, while price decreases occur more often in April, July and October. The three lines are largely unchanged when we include promotions and product replacements in the sample (chart B1). Berardi *et al.* (2015) also obtain very similar trends for consumer prices in France when promotions and seasonal sales are excluded, but, unlike our analysis, they obtain the "January effect" for price cuts when promotions and seasonal sales are included.

In order to better understand the trends in chart 2, we consider the four product categories for which a great deal of heterogeneity is observed in this respect. While the seasonal trends for unprocessed and processed food products are very similar to those for the whole sample (charts B2 and B3), the trends for non-energy industrial goods and services are quite different. Price increases and decreases for non-energy industrial goods occur more often in April and in October, while those for services occur more often in February and in October (charts B4 and B5). As clothes account for one third of non-energy industrial goods in the dataset, the seasonality identified for this product category is most likely explained by winter and summer clothing collections introduced around April and October, respectively. The seasonal trend in services is likely explained by the fact that the largest fraction of these in the dataset is accounted for by restaurants and cafés, where menu prices tend to change at the beginning of the year or after the summer holidays.

1 Producing the statistics by product category while including promotions and product replacements results in slightly bigger price adjustments for all product categories and slightly lower fractions of small price adjustments. Not surprisingly, price decreases are in this case bigger than price increases for all product categories and all parts of the size distributions (table B2).

Chart 2

Mean frequency of price adjustments by month (%), excluding promotions and product replacements



Notes: The mean frequencies by month are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet. Then, we calculate the weighted mean across retailer-brand pairs by month using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007-December 2015.

Similar heterogeneity in the frequency of consumer price changes has been documented by Nakamura and Steinsson (2008) for the US and Berardi *et al.* (2015) for France.

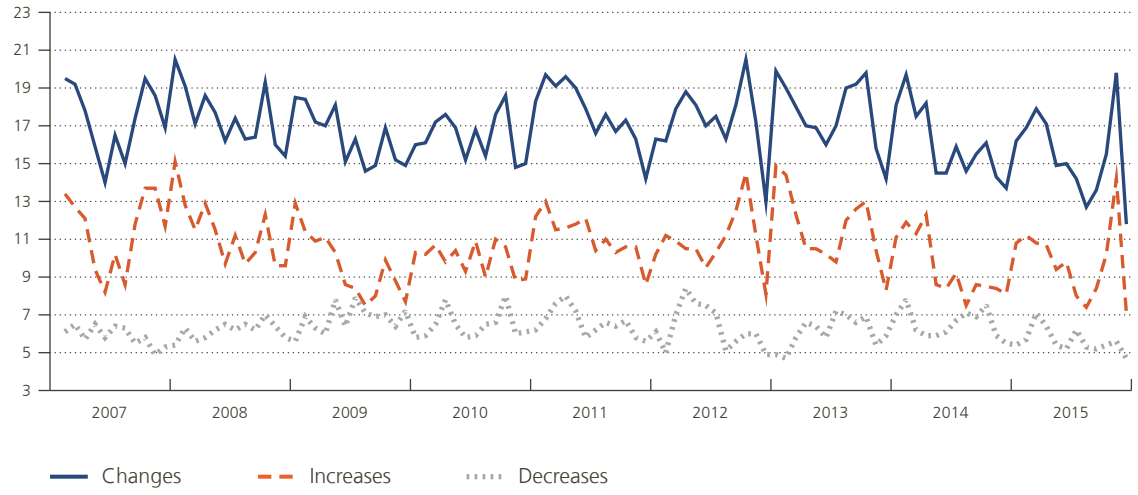
In charts 3 and 4, we plot the mean frequency and absolute size of price changes (solid line), increases (dashed line) and decreases (dotted line) against year-month pairs using the benchmark sample. Conducting this analysis is particularly relevant as the 2007–2015 period was marked by the great financial crisis and its aftermath (2007-2009), the sovereign debt crisis in the euro area, and the low inflation environment in the euro area from early 2013 onwards. In other words, the price-setting behaviour of firms in Belgium over the period examined might have also been determined by macroeconomic and financial shocks, which would point to its state-dependent aspect (Cecchetti, 1985; Caplin *et al.*, 1987; Caplin *et al.*, 1991; Dotsey *et al.*, 1999; Klenow and Kryvtsov, 2008; Nakamura and Steinsson, 2008; Midrigan, 2010; Kehoe and Midrigan, 2015; Dixon *et al.*, 2020). A careful examination of the trends of the mean frequencies and sizes of price increases and decreases over this period suggests that these may be related to such kinds of shocks.

According to chart 3, the mean frequency of price increases exhibits declining trends in the first half of 2007, from January 2008 until the end of 2009, and as of 2013, while it exhibits an increasing trend between January 2010 and December 2012. The mean frequency of price decreases moves mostly in the opposite direction. It is on a rising trend from the end of 2007 until mid-2009 and from 2013 towards the end of 2014, and on a declining trend from the second half of 2011 until the end of 2012. Chart 4 reveals that price decreases are, on average, bigger than price increases from January 2007 until the end of 2009, and in some months of 2013 and 2014. By contrast, price decreases are mostly smaller in 2010-2012. Producing these figures on the sample that includes promotions and product replacements does not alter these trends (figures B6 and B7). As expected, price decreases become more sizeable than price increases in the biggest part of the period examined, and this is particularly evident in 2007-2008, in 2011, the second half of 2012 and 2013 and in 2014 except for its last few months[1].

1 It is noteworthy that we obtain very similar trends to those portrayed in figures 1-3 and B1-B7 by relying on the *median* frequencies and sizes of price increases and decreases. These figures are available upon request.

Chart 3

Mean frequency of price adjustments by year-month (%), excluding promotions and product replacements

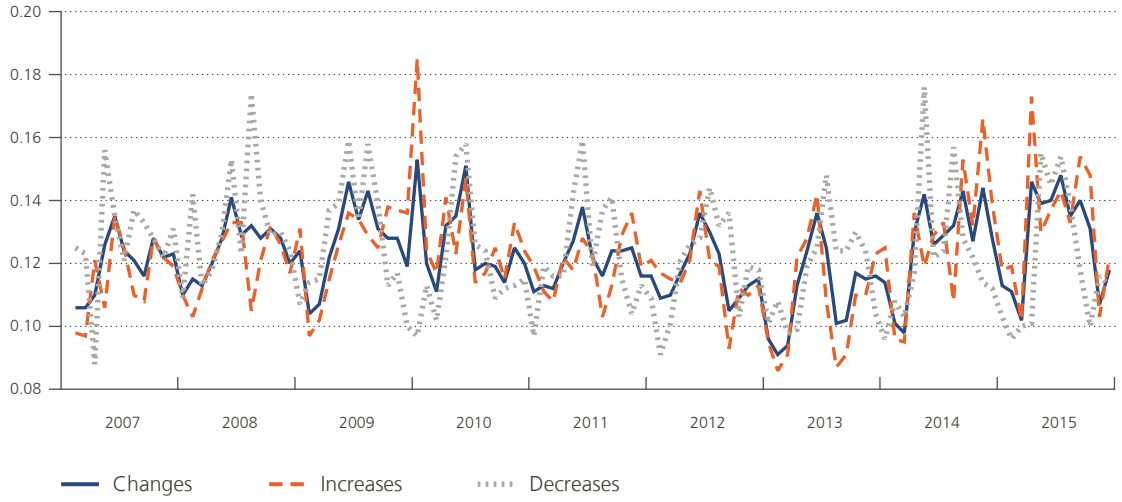


Notes: The mean frequency by year-month is calculated as the weighted mean of the frequency of price changes across retailer-brand pairs by year-month pair using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart 4

Mean size of price adjustments by year-month (log price difference), excluding promotions and product replacements



Notes: The mean frequency by year-month is calculated as the weighted mean of the frequency of price changes across retailer-brand pairs by year-month pair using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Conclusion

Using newly-available micro-level CPI data of monthly frequency for Belgium covering the period from January 2007 to December 2015, we derive a set of stylised facts on the price-setting behaviour of firms regarding products that span four categories: unprocessed food, processed food, non-energy industrial goods and services.

We document that prices change quite frequently (stylised fact 1), downward price adjustments are common (stylised fact 2), and price increases and decreases are relatively sizeable (stylised fact 3). The frequencies and sizes of price adjustments reported in this article are larger than those found by earlier studies, possibly due to the more volatile macroeconomic environment over the period examined compared to the "Great Moderation" period. In addition, the frequencies of price increases and decreases exhibit seasonal trends (stylised fact 4). Heterogeneity in all these dimensions across the four product categories examined is salient (stylised fact 5). Finally, during the great financial crisis and its aftermath (2007-2009) and the low-inflation environment in the euro area (as of 2013), price rises became less frequent, price cuts became more frequent, and price decreases were more sizeable than price increases (stylised fact 6). Despite these trends being intuitive, further research relying on micro-level price data could help us gain a better understanding of state-dependent features of price changes and in particular, of their determinants during periods that are marked by macroeconomic and financial instability, incomplete transmission of monetary policy or simultaneous demand and supply shocks such as those generated by the coronavirus pandemic.

Bibliography

Alvarez L. J., E. Dhyne, M. M. Hoeberichts, C. Kwapil, H. Le Bihan, P. Lunnemann, F. Martins, R. Sabbatini, H. Stahl, Ph. Vermeulen and J. Vilmunen (2006). "Sticky Prices in the Euro Area: A Summary of New Micro Evidence", *Journal of the European Economic Association*, 4, 575-584.

Bils M. and P. J. Klenow (2004). "Some Evidence on the Importance of Sticky Prices", *Journal of Political Economy*, 112, 947-985.

Calvo G. (1983). "Staggered Prices in a Utility-Maximizing Framework", *Journal of Monetary Economics*, 12 (3), 383-98.

Caplin A. and J. Leahy (1991). "State-Dependent Pricing and the Dynamics of Money and Output", *Quarterly Journal of Economics*, 106, 683-708.

Caplin A. and J. Leahy (1997). "Aggregation and Optimization with State-Dependent Pricing" *Econometrica*, 65, 601-625.

Caplin A. and D. Spulber (1987). "Menu Costs and the Neutrality of Money", *Quarterly Journal of Economics*, 102, 703-725.

Cecchetti S. G. (1985). "Staggered Contracts and the Frequency of Price Adjustment", *Quarterly Journal of Economics*, 100, 935-959.

Dixon H., K. luintel and K. Tian (2020). The Impact of the 2008 Crisis on UK prices: What We Can Learn from the CPI Microdata, *Oxford Bulletin of Economics and Statistics*.

Dhyne E., L. J. Alvarez, H. Le Bihan, G. Veronese, D. Dias, J. Hoffmann, N. Jonker, P. Lunnemann, F. Rumler and J. Vilmunen (2006). "Price Changes in the Euro Area and the United States: Some Facts from Individual Consumer Price Data", *Journal of Economic Perspectives*, 20, 171-92.

Dias D., C. Robalo Marques and J. M. Santo Silva (2007). "Time or State Dependent Price Setting Rules? Evidence from Micro Data", *European Economic Review*, 51, 1589-1613.

Dotsey M., R. King and A. Wolman (1999). "State-Dependent Pricing and the General Equilibrium Dynamics of Money and Output", *Quarterly Journal of Economics*, 114, 655-690.

Fabiani S., M. Druant, I. Hernando, C. Kwapil, B. Landau, C. Loupias, F. Martins, Th. Matha, R. Sabbatini, H. Stahl and A. Stokman (2006). "What Firms' Surveys Tell Us about Price-Setting Behavior in the Euro Area", *Journal of International Central Banking*, 2(3), 1-47.

Gagnon E. (2009). "Price Setting during Low and High Inflation: Evidence from Mexico", *Quarterly Journal of Economics*, 124, 1221-63.

Kehoe P. and M. Virgiliu (2015). "Prices are sticky after all", *Journal of Monetary Economics*, 75(C), 35-53.

Klenow J. P. and O. Kryvtsov (2008). "State-Dependent or Time-Dependent Pricing: Does It Matter for Recent US Inflation?", *Quarterly Journal of Economics*, 123, 863-904.

Klenow J. P. and B. Malin (2010). "Microeconomic Evidence on Price-Setting", *Handbook of Monetary Economics*, 3, 231-84.

Midrigan V. (2010). "Is Firm Pricing State or Time Dependent? Evidence from U.S. Manufacturing", *The Review of Economics and Statistics*, 92(3), 643-656.

Nakamura E. and J. Steinsson (2008). "Five Facts about Prices: A Reevalutaion of Menu Cost Models", *Quarterly Journal of Economics*, 123, 1415-64.

Nakamura E. and J. Steinsson (2013). "Price Rigidity: Microeconomic Evidence and Macroeconomic Implications", *Annual Review of Economics*, 5, 133-63.

Taylor J. B. (1980). "Aggregate Dynamics and Staggered Contracts", *Journal of Political Economy* 88 (1), 1-23.

Wulfsberg F. (2016). "Inflation and Price Adjustments: Micro Evidence from Norwegian Consumer Prices 1975-2004", *American Economic Journal: Macroeconomics*.

Annexes

A. Data Appendix

Table A1

Products covered in the dataset

5-digit COICOP	Description	Average Weight 2007-2015 (‰)
01.1.1.1	Rice	0.40
01.1.1.2	Flours and other cereals	0.63
01.1.1.3	Bread	11.27
01.1.1.4	Other bakery products	11.92
01.1.1.5	Pizza and quiche	1.74
01.1.1.6	Pasta products and couscous	2.28
01.1.1.7	Breakfast cereals	1.23
01.1.1.8	Other cereal products	1.02
01.1.2.1	Beef and veal	7.37
01.1.2.2	Pork	2.65
01.1.2.3	Lamb and goat meat	1.16
01.1.2.4	Poultry	4.54
01.1.2.5	Other meats	1.43
01.1.2.7	Dried, salted or smoked meat	12.58
01.1.2.8	Other meat preparations	15.02
01.1.3.1	Fresh or chilled fish	4.45
01.1.3.2	Frozen fish	1.20
01.1.3.3	Fresh or chilled seafood	0.64
01.1.3.4	Frozen seafood	0.19
01.1.3.5	Dried, smoked or salted fish	0.83
01.1.3.6	Other preserved or processed fish and seafood and fish and seafood preparations	2.46
01.1.4.1	Fresh whole milk	0.86
01.1.4.2	Fresh low fat milk	1.67
01.1.4.3	Preserved milk	0.27
01.1.4.4	Yoghurt	3.45
01.1.4.5	Cheese and curd	10.81
01.1.4.6	Other milk products	2.34
01.1.4.7	Eggs	1.08
01.1.5.1	Butter	1.28
01.1.5.2	Margarine and other vegetable fats	1.50
01.1.5.3	Olive oil	0.67
01.1.5.4	Other edible oils	0.68
01.1.6.1	Fresh or chilled fruit	9.89
01.1.6.3	Dried fruit and nuts	0.81
01.1.6.4	Preserved fruit and fruit-based products	0.41
01.1.7.1	Fresh or chilled vegetables other than potatoes and other tubers	7.97
01.1.7.2	Frozen vegetables other than potatoes and other tubers	1.01
01.1.7.3	Dried vegetables, other preserved or processed vegetables	2.86
01.1.7.4	Potatoes	2.25
01.1.7.5	Crisps	1.36
01.1.8.1	Sugar	0.59
01.1.8.2	Jams, marmalades and honey	1.20
01.1.8.3	Chocolate	6.49
01.1.8.4	Confectionery products	0.78
01.1.8.5	Edible ices and ice cream	1.87

5-digit COICOP	Description	Average Weight 2007-2015 (‰)
01.1.9.1	Sauces, condiments	2.92
01.1.9.2	Salt, spices and culinary herbs	0.31
01.1.9.3	Baby food	1.24
01.1.9.4	Ready-made meals	1.12
01.1.9.9	Other food products n.e.c.	1.78
01.2.1.1	Coffee	3.13
01.2.1.2	Tea	0.46
01.2.1.3	Cocoa and powdered chocolate	0.17
01.2.2.1	Mineral or spring waters	3.70
01.2.2.2	Soft drinks	7.23
01.2.2.3	Fruit and vegetable juices	2.47
02.1.1.1	Spirits and liqueurs	2.02
02.1.1.2	Alcoholic soft drinks	0.02
02.1.2.1	Wine from grapes	9.62
02.1.2.2	Wine from other fruits	0.03
02.1.2.3	Fortified wines	1.35
02.1.3.1	Lager beer	2.38
02.1.3.2	Other alcoholic beer	2.08
02.2.0.1	Cigarettes	7.62
02.2.0.3	Other tobacco products	2.27
03.1.2.1	Garments for men	13.47
03.1.2.2	Garments for women	24.99
03.1.2.3	Garments for infants (0 to 2 years) and children (3 to 13 years)	9.29
03.2.1.1	Footwear for men	3.25
03.2.1.2	Footwear for women	5.39
03.2.1.3	Footwear for infants and children	3.25
04.3.2.1	Services of plumbers	1.87
04.3.2.2	Services of electricians	1.78
04.3.2.3	Maintenance services for heating systems	1.78
04.3.2.4	Services of painters	1.62
04.4.4.9	Other services related to dwelling	0.98
05.1.1.1	Household furniture	16.03
05.1.1.2	Garden furniture	1.22
05.1.1.3	Lighting equipment	2.46
05.1.1.9	Other furniture and furnishings	2.35
07.1.1.1	New motor cars	68.65
07.1.2.0	Motor cycles	3.12
07.1.3.0	Bicycles	2.36
07.2.3.0	Maintenance and repair of personal transport equipment	17.21
09.3.1.1	Games, toys and hobbies	3.15
09.3.1.2	Toys and celebration articles	3.41
11.1.1.1	Restaurants, cafés and dancing establishments	46.49
11.1.1.2	Fast food and take away food services	11.58
11.2.0.3	Accommodation services of other establishments	0.33
12.1.1.1	Hairdressing for men and children	1.48
12.1.1.2	Hairdressing for women	8.81
12.1.1.3	Personal grooming treatments	1.24
12.7.0.1	Administrative fees	1.57
12.7.0.3	Funeral services	0.69
12.7.0.4	Other fees and services	1.75
Total		460.59

Table A2

Product coverage

Product category	Price quotes		Weight in our sample, average 2007-2015	Weight in total CPI, average 2007-2015
	No.	%	%	%
Processed food	3,626,419	42.3	12.5	12.5
Unprocessed food	3,052,145	35.6	8.3	8.3
Non-energy industrial goods	1,218,185	14.2	16.2	30.7
Services	678,595	7.9	9.9	36.2
Energy	0	0	0	12.3
Total	8,575,344	100	46.1	100

Source: Authors' calculations based on the micro-level and aggregate CPI data for Belgium over the period January 2007 - December 2015.

B. Appendix with additional descriptive statistics

Table B1

Frequency of price changes by product category, including promotions and product replacements

	Frequency (%)			Fraction (%)	Implied Duration (months)
	Changes	Increases	Decreases	Decreases	–1 / ln (1-Freq)
Panel A: Unprocessed food					
Mean	30.4	16.3	13.9	45.8	2.8
Median	19.5	11.8	7.7	39.5	4.6
Panel B: Processed food					
Mean	20.6	12	8.6	41.8	4.3
Median	21.6	12.8	9.3	42.9	4.1
Panel C: Non-energy industrial goods					
Mean	7.2	5	2.3	31.1	13.3
Median	7.3	4.8	1.9	25.4	13.2
Panel D: Services					
Mean	3.7	3.3	0.4	12.1	26.5
Median	3.4	3.1	0.3	9.3	28.8

Notes: Mean and median frequencies are calculated in two steps. First, we calculate the unweighted mean of the frequency of price changes across year-month pairs by retailer-brand pair and product category. Then, we calculate the weighted mean or median across retailer-brand pairs by product category using the 6-digit COICOP weights. The fraction of price decreases and implied duration are calculated as in table 1. Frequencies of price changes and the fraction of price decreases are in percentages. Implied durations represent the number of months during which prices remain unchanged. Calculating the mean (median) implied duration of Panels A, B, C and D as the inverse of the mean (median) frequency of price changes, 1/Freq, yields 3.3, 4.8, 13.8 and 27 (5.1, 4.6, 13.4 and 29.3) months.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Table B2

Size of price changes by product category, including promotions and product replacements

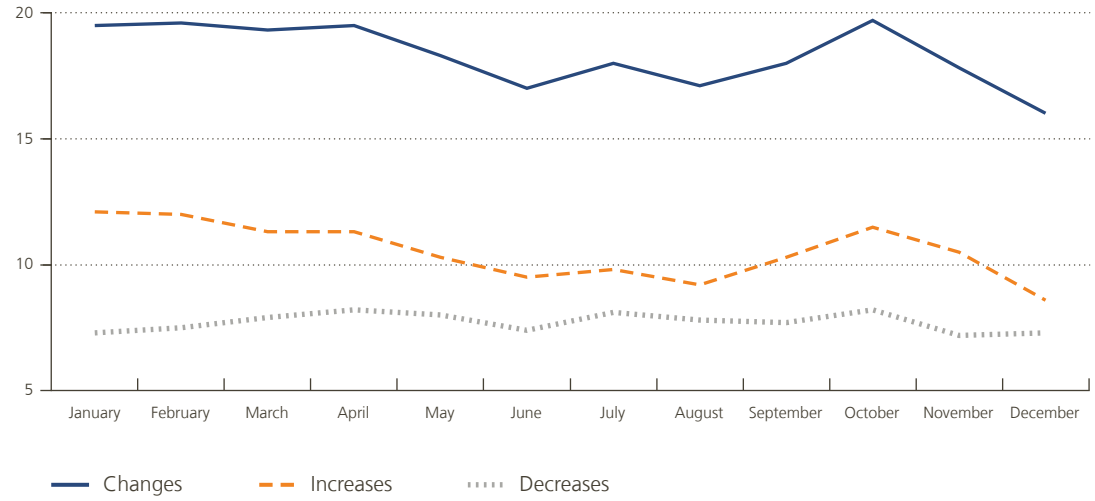
	Size (log price difference)				Fraction (%)	
	Mean	Median	P25	P75	Size ≤ 1 %	Size ≤ 2 %
Panel A: Unprocessed food						
Changes	0.191	0.172	0.138	0.246	3.6	7.8
Increases	0.179	0.149	0.116	0.24	3.7	8.4
Decreases	0.205	0.19	0.157	0.249	3.5	7.2
Panel B: Processed food						
Changes	0.078	0.075	0.064	0.09	9.9	22.3
Increases	0.076	0.076	0.063	0.09	8.3	20.5
Decreases	0.081	0.076	0.061	0.095	12	24.5
Panel C: Non-energy industrial goods						
Changes	0.097	0.108	0.019	0.138	6.8	10.5
Increases	0.08	0.087	0.018	0.123	7	11.5
Decreases	0.136	0.134	0.113	0.166	6.4	9
Panel D: Services						
Changes	0.073	0.073	0.062	0.078	4.1	11.6
Increases	0.072	0.072	0.062	0.082	3.7	11.3
Decreases	0.082	0.078	0.068	0.094	7.3	13.9

Notes: The size of price changes is the log price difference in two consecutive months. The statistics for the size of price changes are calculated in two steps. First, we calculate the unweighted mean of the size of price changes across year-month pairs by retailer-brand pair and product category. Then, we calculate the weighted mean, median, P25 or P75 value across retailer-brand pairs by product category using the 6-digit COICOP weights. The fractions of small price changes (less than 1 % and 2 %) are in percentages.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B1

Mean frequency of price adjustments by month (%), including promotions and product replacements

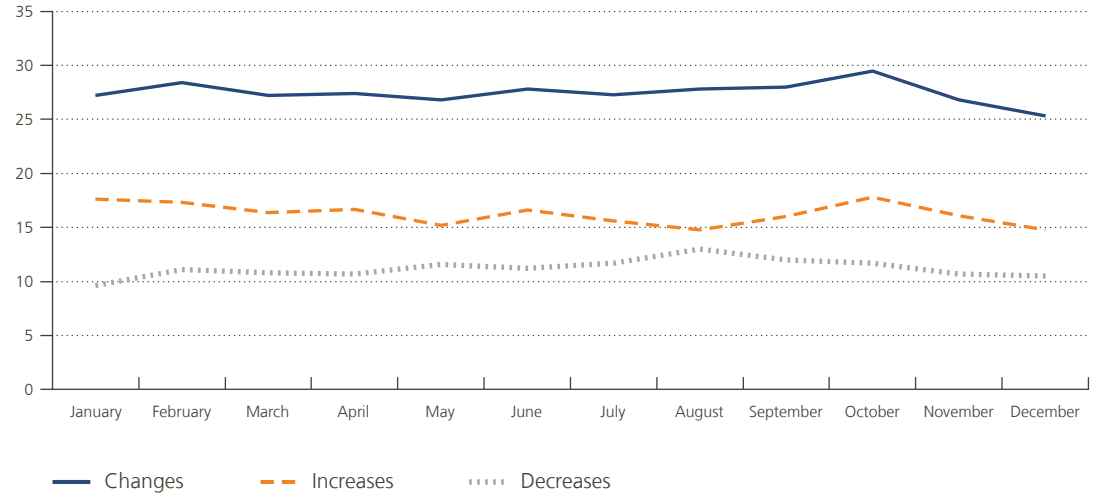


Notes: The mean frequencies by month are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet. Then, we calculate the weighted mean across retailer-brand pairs by month using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B2

Mean frequency of price adjustments by month (%), unprocessed food

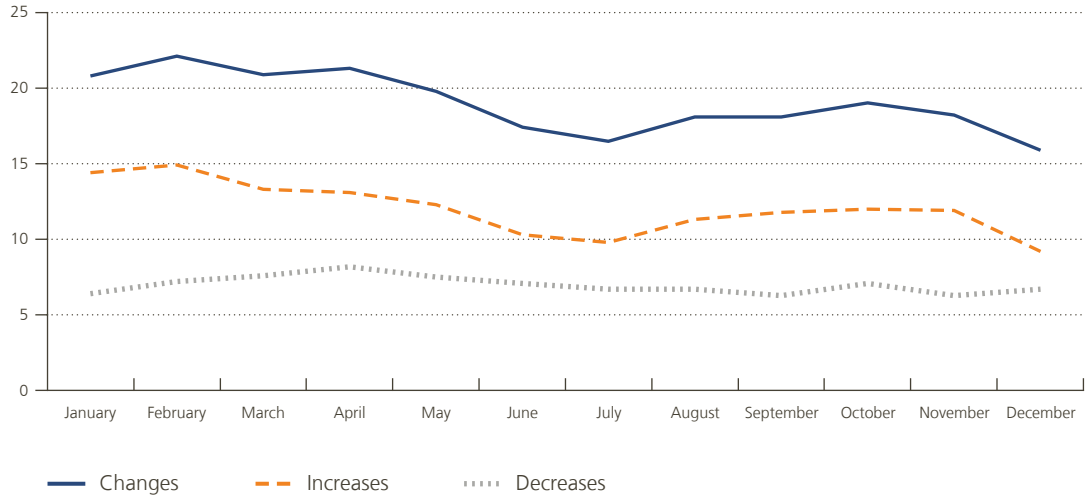


Notes: The mean frequencies by month and product category are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet and product category. Then, we calculate the weighted mean across retailer-brand pairs by month and product category using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B3

Mean frequency of price adjustments by month (%), processed food

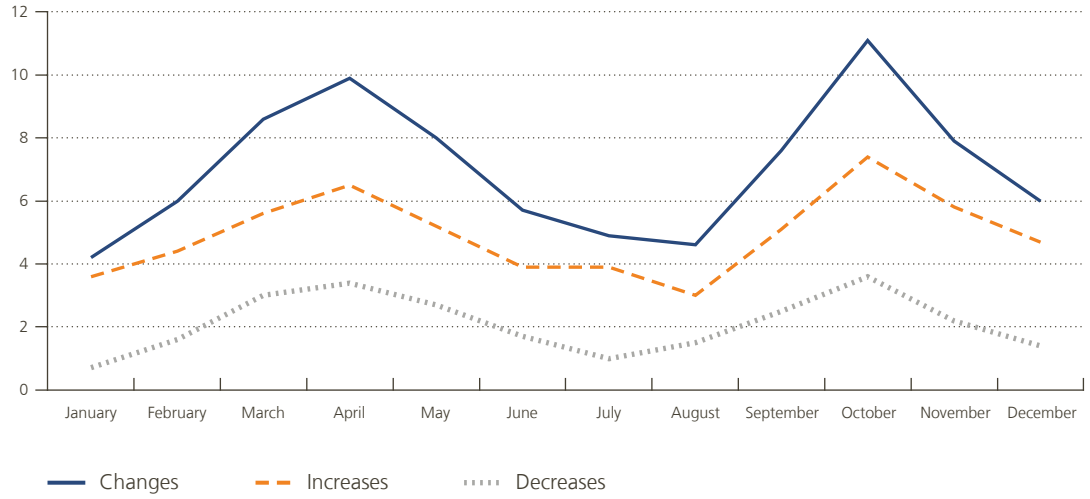


Notes: The mean frequencies by month and product category are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet and product category. Then, we calculate the weighted mean across retailer-brand pairs by month and product category using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B4

Mean frequency of price adjustments by month (%), non-energy industrial goods

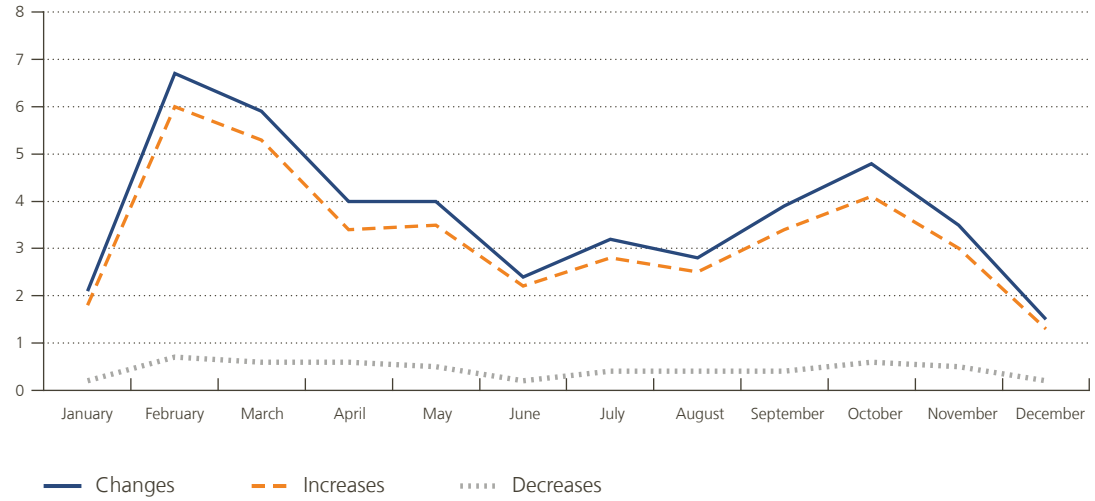


Notes: The mean frequencies by month and product category are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet and product category. Then, we calculate the weighted mean across retailer-brand pairs by month and product category using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B5

Mean frequency of price adjustments by month (%), services

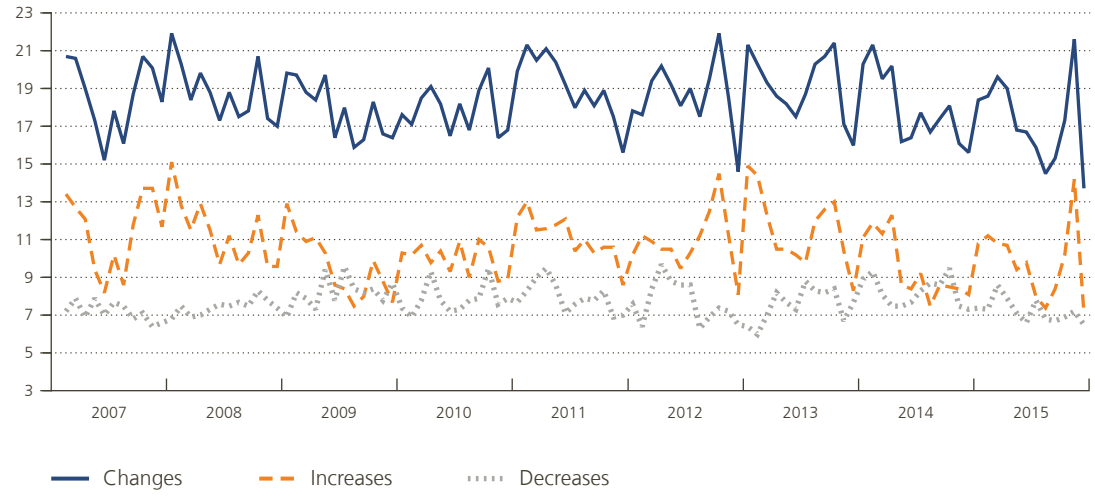


Notes: The mean frequencies by month and product category are calculated in two steps. First, we calculate the unweighted mean of the frequency or size of price changes across years by retailer-brand-month triplet and product category. Then, we calculate the weighted mean across retailer-brand pairs by month and product category using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B6

Mean frequency of price adjustments by year-month (%), including promotions and product replacements

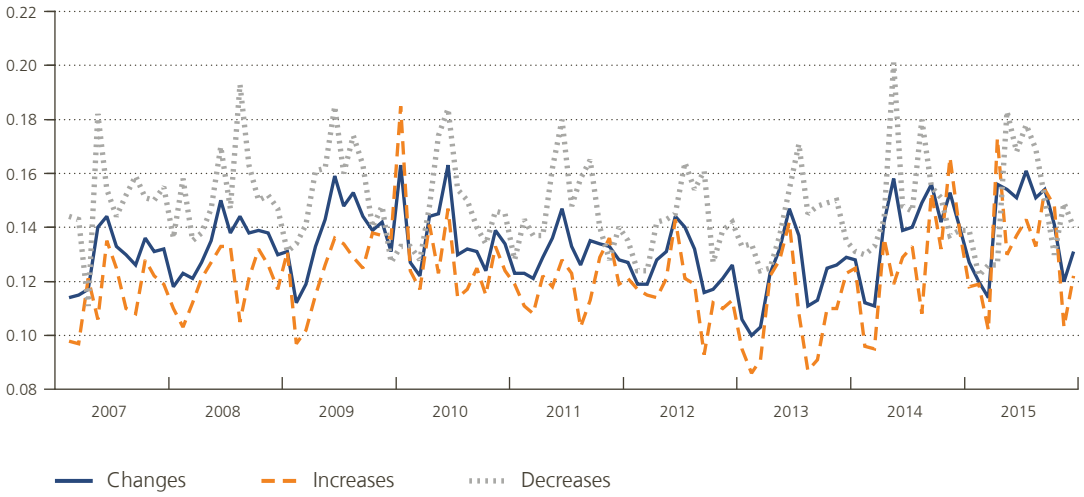


Notes: The mean frequency by year-month is calculated as the weighted mean of the frequency of price changes across retailer-brand pairs by year-month pair using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.

Chart B7

Mean size of price adjustments by year-month (log price difference), including promotions and product replacements



Notes: The mean size by year-month is calculated as the weighted mean of the size of price changes across retailer-brand pairs by year-month pair using the 6-digit COICOP weights.

Source: Authors' calculations based on the micro-level CPI data for Belgium over the period January 2007 - December 2015.