

Micro Empirical Evidence on Price Adjustment

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Keywords: Micro Empirical; Evidence; Price Adjustment

Abstract. This essay categorizes the empirical evidence by developed countries firstly and developing countries secondly. Within these two groups, this essay divides each group into two subgroups, by general and specific evidence. In addition, we allow the inclusion of evidence on seasonal price changes on developed countries.

Introduction

Since the development of New Keynesian Models provided theoretical foundations for price staggering behavior, it is thus a natural attempt to delve into real world price setting policy at micro-economic level (Romer, 2012). The distinct feature between time-dependent models (TDP) and state-dependent models (SDP) had been subsequently developed to model price staggering behavior and were tested by plotting in the microeconomic data (Walsh, 2010). Vast attempts have been devoted in the investigations of price setting behaviors by plotting in price data (normally as Consumer Price Index). The idiosyncratic feature of this essay is not matching the price data to the theoretical models; rather, to provide a qualitative measure on sheer price behavior across different regions worldwide.

Empirical Evidence for Developed Countries

This part will analyze the empirical evidence on individual consumer price data, focusing on developed area, especially Europe. The data are conducted on a common sample of 50 goods or services, during the January 1996 to January 2001. Moreover, the 50 products are categorized into five kinds, shown in Table 1. For data harmonizing, the product turnover is considered and there is a control for sample differences in inflation. In addition, the effect of sales is considered as well, which will be discussed further as a specific issue in the last part.

Table 1

Approximating Consumer Goods with 50 Product Categories

<i>General category</i>	<i>Specific category</i>
Unprocessed food categories	Steak, fresh fish, lettuce, banana
Processed food categories	Milk, sugar, frozen spinach, mineral water, coffee
Energy (oil) products	Gasoline for heating, two types of fuels
Non-energy industrial goods	Socks, jeans, sport shoes, shirt, acrylic paint, cement, toaster, electric bulb, 1 type of furniture, towel, car tire, television set, dog food, tennis ball, Lego box or equivalent, toothpaste, suitcase
Services	Dry cleaning; hourly rate of an electrician; hourly rate of a plumber; domestic services; hourly rate in a garage; car wash; balancing of wheels; taxi; movie; videotape rental; photo development; hotel room; glass of beer in a bar; meal in a restaurant; hot-dog; Coca-cola or equivalent, in a bar, men's haircut; ladies' hairdressing

Note: If one product category was not available, it was replaced by a similar product or—in a few cases—left out (for example, energy products are not covered in Spain).

(Table 1, Emmanuel, 2006)

Based on the table 1, there are some basic facts. Generally, the mean duration of a price spell in euro is 13 months and monthly 15.1% adjustment, which is a relatively lagged price adjustment, showing the stickiness. However, considering different dimensions, it suggests that various flexibilities result from different considerations.

Firstly, the price changes are relatively frequent for energy products and unprocessed food, but infrequent for processed food and services correspondingly, which means rigidity effects give more importance on service area. Furthermore, Emmanuel (2006) pointed that frequent price change exists more common in capital-intensive industry than labor-intensive industry. Correspondingly, the average price adjustment in energy is 78% in a given month, but that in services is only 5.6%(Table 2). Besides, restricted regulation on price could explain the stickiness in some areas such as processed food.

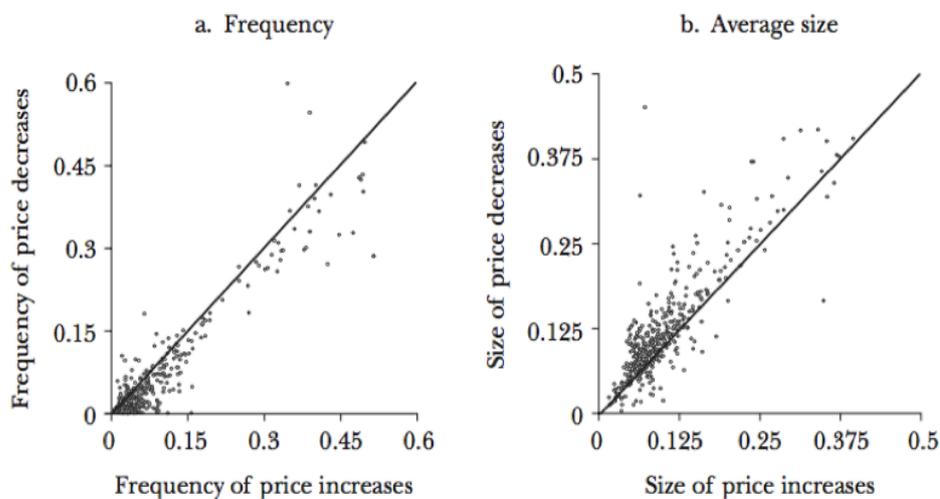
Frequency of Price Changes by Product Types^a

	<i>Unprocessed food</i>	<i>Processed food</i>	<i>Energy (oil products)</i>	<i>Non-energy industrial goods</i>	<i>Services</i>	<i>Total^b country weights</i>	<i>Total^c euro area weights</i>
Austria	37.5	15.5	72.3	8.4	7.1	15.4	17.1
Belgium	31.5	19.1	81.6	5.9	3.0	17.6	15.6
Germany	25.2	8.9	91.4	5.4	4.3	13.5	15.0
Spain ^d	50.9	17.7	n.a.	6.1	4.6	13.3	11.5
Finland	52.7	12.8	89.3	18.1	11.6	20.3	—
France	24.7	20.3	76.9	18.0	7.4	20.9	20.4
Italy	19.3	9.4	61.6	5.8	4.6	10.0	12.0
Luxembourg	54.6	10.5	73.9	14.5	4.8	23.0	19.2
Netherlands	30.8	17.3	72.6	14.2	7.9	16.2	19.0
Portugal	55.3	24.5	15.9	14.3	13.6	21.1	18.7
Euro area	28.3	13.7	78.0	9.2	5.6	15.1	15.8
United States	47.7	27.1	74.1	22.4	15.0	24.8	27.2

(Table 2, Emmanuel, 2006)

Secondly, regarding to the price change directions, Figure 1 illustrates that the price increase and reduction have different effects in magnitude and frequency. When the price rises, it seems to be high frequency with small size. On the contrary, infrequent and sizeable price adjustment happens when decreasing.

Characterizing Price Increases and Price Decreases



Sources: National Central Banks calculations on data from the national statistical institutes.
Notes: Pooled data of 50 product categories in nine countries. (Finland is not included.)

(Figure 1, Emmanuel, 2006)

Generally, stickiness is common, but there are various factors affecting the frequency and size in the different degrees. As well, there are also some other evidence proving the price stickiness in developed countries.

Table 3 analyzes the estimate of monthly mean frequency of CPI price changes, which clearly exhibits nominal stickiness, with a mean frequency of 19% per month. The degree of stickiness varies across countries, with prices in the Euro area changing less frequently than those in U.S. and developing countries. Next, the section will mainly focus on one typical country case, with a high-frequency data set of prices reported in Hungary.

Monthly Mean Frequency of CPI Price Changes

Country	Paper	Sample Period	Frequency (in %)
Austria	Baumgartner <i>et al.</i> (2005)	1996:01 – 2003:12	15.1
Belgium	Aucremanne and Dhyne (2004)	1989:01 – 2001:01	16.9
Brazil	Barros <i>et al.</i> (2009)	1996:03 – 2008:12	37.2
	Gouvea (2007)	1996:01 – 2006:12	37.0
Chile	Medina <i>et al.</i> (2007)	1999:01 – 2005:07	46.1
Denmark	Hansen and Hansen (2006)	1997:01 – 2005:12	17.3
Euro Area	Dhyne <i>et al.</i> (2006)	1996:01 – 2001:01	15.1
Finland	Vilimunen and Laakkonen (2005)	1997:01 – 2003:12	16.5
France	Baudry <i>et al.</i> (2007)	1994:07 – 2003:02	18.9
Germany	Hoffmann and Kurz-Kim (2006)	1998:02 – 2004:01	11.3
Hungary	Gabriel and Reiff (2008)	2001:12 – 2007:06	15.1
Israel	Baharad and Eden (2004)	1991:01 – 1992:12	24.5
Italy	Fabiani <i>et al.</i> (2006)	1996:01 – 2003:12	10.0
Japan	Saita <i>et al.</i> (2006)	1999:01 – 2003:12	23.1
Luxembourg	Lunnemann and Matha (2005)	1999:01 – 2004:12	17.0
Mexico	Gagnon (2009)	1994:01 – 2004:12	29.4
Netherlands	Jonker <i>et al.</i> (2004)	1998:11 – 2003:04	16.5
Norway	Wulfsberg (2009)	1975:01 – 2004:12	21.3 (21.9)
Portugal	Dias <i>et al.</i> (2004)	1992:01 – 2001:01	22.2
Sierra Leone	Kovanen (2006)	1999:01 – 2003:04	51.5
Slovakia	Coricelli and Horvath (2006)	1997:01 – 2001:12	34.0
South Africa	Creamer and Rankin (2008)	2001:12 – 2006:02	16.0
Spain	Álvarez and Hernando (2006)	1993:01 – 2001:12	15.0
United Kingdom	Bunn and Ellis (2009)	1996:01 – 2006:01	15 (19)
United States	Bills and Klenow (2004)	1995:01 – 1997:12	26.1
	Klenow and Kryvtsov (2008)	1988:02 – 2005:01	29.9 (36.2)
	Nakamura and Steinsson (2008a)	1988:01 – 2005:12	21.1 (26.5)

Notes: Source: Álvarez (2008) with three additional studies, Barros *et al.* (2009), Bunn and Ellis (2009) and Wulfsberg (2009), and updated versions of Gagnon (2009), Creamer and Rankin (2008), and Klenow and Kryvtsov (2008). For studies that report frequencies of both regular (i.e., non-sale) and posted prices, the figures in parentheses correspond to posted prices. Frequencies for Nakamura and Steinsson (2008a) correspond to the 1998-2005 sample period (for contiguous observations, excluding substitutions). For Germany, frequencies refer to the sample considering item replacements and non-quality adjusted data. The Spanish sample excludes energy products, which lowers the aggregate frequency.

(Table 3, Peter and Benjamin, 2010)

Tables 4(a) and (b) show the statistics of the product-specific and store-specific duration of price quotations in Hungary. Table 4(b) also shows the separate information of duration of price quotations in large department stores and small grocery stores, which reveals that large stores have a clear tendency with less frequent price adjustments. The reason why large department stores have lower tendency to change prices could be that their marginal revenue is more procyclical and steeper, leading to a greater real rigidity. Price cuts occur frequently, and the size of which is systematically smaller than price increases.

Table 4 The Duration of Price Quotations: (a) Products and (b) Stores

	Product	rk	hk	sc	so	sd	mf	mr	msz	vi	lk	sl	st	fft	esz	Mean	Standard deviation
(a)																	
P1	Dur	2.43	2.32	2.16	2.42	2.53	2.83	2.97	2.96	3.59	3.40	2.27	2.15	2.88	3.01	2.71	0.45
	Max	11	10	10	9	10	7	7	10	15	10	9	9	17	11	10.36	2.71
P2	Dur	1.90	1.80	1.71	2.00	1.77	6.00	7.52	6.91	3.40	4.73	1.80	1.80	4.79	4.76	3.64	2.12
	Max	5	4	4	6	4	16	16	16	10	13	4	5	12	11	9.00	4.95
	Stores	n4	n2	n1	n11	n5	n3	k6	k4	k3	Group mean 'n' (n4,n2,n1, n11,n5,n3)		Group mean 'k' (k6,k4,k3)		Overall mean	Standard deviation	
(b)																	
P1	Dur	3.08	2.37	3.42	2.65	3.12	2.42	2.87	2.18	2.27	2.84			2.44		2.71	0.44
P2	Dur	3.98	3.31	5.22	2.79	5.77	3.64	2.68	2.58	2.76	4.12			2.68		3.64	1.16

Notes: The figures are in months. 'Dur' denotes the mean duration of price quotations; 'Max' denotes the longest duration; Product name abbreviations are in Table 1; Stores with mnemonic 'n' are supermarkets. Stores with mnemonic 'k' are grocery stores; 'P1' refers to Period 1, 'P2' refers to Period 2.

(Table 4, Attila, 2007)

To conclude, considering the fact that the prices are highly volatile or trending upwards, the results reveal that prices fluctuate less frequently and perform strong stickiness in developed countries, which supports the evidence for macroeconomic pricing models, with price adjustment exhibiting heterogeneity, state-dependence and lumpiness.

Empirical Evidence for Developing Countries

Some results about price stickiness have been obtained for developed countries. This section will answer the question 'Are prices also sticky in the developing countries?' by estimating the duration of price adjustment in four emerging Latin-American countries, namely, Chile, Brazil, Colombia, and Mexico. These four countries were chosen as a result of adopting similar monetary policy that is inflation targeting and experiencing a low and stable inflation rate.

The sample was collected from the construction of CPI in each of the four countries (Felipe and Mauricio, 2008). In each country, different groups of goods are classified relying on the type of individual products. In the Table 5, the term observation represents the price of individual product at a given time point, and the term price spell means the time interval between two price changes. According to this table, two general features about the duration can be obtained. Firstly, the table illustrates that the products that change price less frequently occupy more weights in the CPI basket for each of four economies, since the largest duration is found using the measure considering the CPI weights. Secondly, the duration distribution tends to be right-skewed due to the fact that the mean is always higher than the median. It indicates that products changing price more frequently account for greater weights in the numbers of observations.

Country	Number of Observations	Mean	Median	Standard Deviation
<i>Brazil (1999:8 - 2006:6)</i>				
All price spells	27,390	1.51	1.00	1.36
Price spells averaged by individual trajectory(*)	512	1.74	1.47	1.10
Price spells averaged by individual trajectory(*) (Weighted)	512	2.13	1.88	1.04
<i>Colombia (1999:1 - 2006:10)</i>				
All price spells	7,591	2.13	1.00	2.47
Price spells averaged by individual trajectory(*)	176	2.68	2.24	1.49
Price spells averaged by individual trajectory(*) (Weighted)	176	3.56	2.42	2.14
<i>Chile (1998:12 - 2006:10)</i>				
All price spells	21,422	2.09	1.00	2.94
Price spells averaged by individual trajectory(*)	482	3.26	2.11	3.75
Price spells averaged by individual trajectory(*) (Weighted)	482	3.42	2.12	4.09
<i>Mexico (1995:1 - 2006:10)</i>				
All price spells	23,747	1.60	1.00	2.09
Price spells averaged by individual trajectory(*)	271	1.86	1.63	1.32
Price spells averaged by individual trajectory(*) (Weighted)	271	2.06	1.77	1.45

(*) The average by individual trajectory for each product was done utilizing, as a weight, the inverse of number of price spells.

(Table 5, Felipe and Mauricio, 2008)

Additionally, it can be found that these emerging countries have a less degree of nominal rigidity with the duration of appropriately between two and three months, compared to the developed countries mentioned before. Finally, table 6 shows that the heterogeneity exists across the distinct product groups in terms of the average duration. For example, less-processed products such as food items tend to exhibit a less rigid price adjustment than others.

Country/Group	Unweighted			Weighted		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
<i>Brazil (1999:8 - 2006:6)</i>						
Food and Beverages	1.33	1.27	0.26	1.57	1.47	0.37
Communication	3.25	2.44	2.14	3.58	3.68	0.66
Education	2.95	2.53	1.28	4.17	4.50	1.32
Household Articles	1.55	1.53	0.20	1.64	1.65	0.19
Personal Expenses	2.42	1.72	2.04	2.62	2.13	1.50
Medical Care	2.41	2.13	1.01	2.35	2.25	1.05
Transportation	3.04	2.14	2.54	2.09	1.88	0.90
Apparel	1.59	1.53	0.27	1.63	1.62	0.25
Housing	1.64	1.58	0.43	1.92	2.03	0.21
<i>Total</i>	<i>1.74</i>	<i>1.47</i>	<i>1.10</i>	<i>2.13</i>	<i>1.88</i>	<i>1.04</i>
<i>Colombia (1999:1 - 2006:10)</i>						
Food	1.76	1.69	0.63	2.14	2.14	0.81
Culture, Entertainment and Recreation	2.83	2.33	1.17	2.78	2.24	1.15
Education	3.97	4.28	1.30	4.60	4.38	0.86
Other Expenses	2.23	2.25	0.60	2.19	2.42	0.45
Medical Care	2.27	2.30	0.65	1.95	2.24	0.63
Transportation and Communication	2.75	2.19	1.28	2.57	2.00	1.35
Apparel	4.70	4.38	2.03	5.12	4.84	1.76
Housing	2.69	2.19	1.30	5.55	7.08	2.24
<i>Total</i>	<i>2.68</i>	<i>2.24</i>	<i>1.49</i>	<i>3.56</i>	<i>2.42</i>	<i>2.14</i>
<i>Chile (1998:12 - 2006:10)</i>						
Food	1.65	1.43	0.71	2.01	1.48	0.97
Education and Entertainment	6.34	3.21	8.51	8.51	7.15	9.12
Household Articles	2.96	2.45	1.67	2.90	2.38	1.57
Other Expenses	4.97	4.29	3.03	3.69	2.45	2.66
Medical Care	3.07	2.25	1.80	3.84	2.74	2.37
Transportation	3.15	2.38	2.43	2.36	1.50	2.14
Apparel	4.76	4.43	3.51	4.35	1.94	3.78
Housing	3.43	3.00	2.28	2.58	2.02	1.26
<i>Total</i>	<i>3.26</i>	<i>2.11</i>	<i>3.75</i>	<i>3.42</i>	<i>2.12</i>	<i>4.09</i>
<i>Mexico (1995:1 - 2006:10)</i>						
Food and Beverages	1.48	1.48	0.37	1.71	1.65	0.49
Education and Entertainment	2.71	1.97	1.82	2.30	1.87	1.20
Household Articles	1.71	1.69	0.23	1.67	1.59	0.21
Other Services	1.73	1.60	0.29	1.55	1.51	0.10
Medical Care	1.53	1.47	0.21	1.61	1.59	0.21
Transportation	2.72	2.06	2.04	2.60	2.64	1.09
Apparel	1.79	1.75	0.24	1.81	1.79	0.21
Housing	5.07	3.26	4.57	2.53	1.79	2.64
<i>Total</i>	<i>1.86</i>	<i>1.63</i>	<i>1.32</i>	<i>2.06</i>	<i>1.77</i>	<i>1.45</i>

(Table 6, Felipe and Mauricio, 2008)

Brazil can be taken as a more detailed example. Extensive data was collected from almost 500 products and services in 7 different sectors (Food, Housing, Apparel, Medical and Personal Care, Education and Recreation, Transportation and Other Goods and Services) from March 1996 to April 2006 (Gouvea, 2007). And about 9 million observations were involved in order to assess the price rigidity in Brazil. Table 7 shows how often does price change by CPI sector. It is clear that heterogeneity can be seen in price-setting behavior across different sectors. To be more precise, price adjustment in food sector is more frequent mainly due to seasonality. In addition, non-processed food, which is easier to be perishable, also results in high flexibility of price setting. Similarly, price in apparel sector is also affected by seasonality. However, high rigidity, represented by less flexibility and long duration, could be seen in those service sectors and possible reason should be the wage which is usually signed in contracts at the beginning of long-period employment.

Frequency and Implied Duration of Price Changes by CPI Sector

CPI Sector	Frequency	Mean Dur*	Mean Dur**	Median Dur
Food	0.42	2.41	1.86	1.67
Other Goods and Services	0.19	5.29	4.78	3.67
Education and Recreation	0.15	6.68	6.17	4.63
Housing	0.43	2.3	1.75	1.59
Medical and Personal Care	0.25	3.93	3.41	2.73
Transportation	0.35	2.82	2.29	1.95
Apparel	0.58	1.71	1.14	1.19
Overall CPI	0.37	2.68	2.14	1.86

Note: *Assuming whenever prices are changed it occurs once within a given month interval. **Assuming price can change at any point in time.

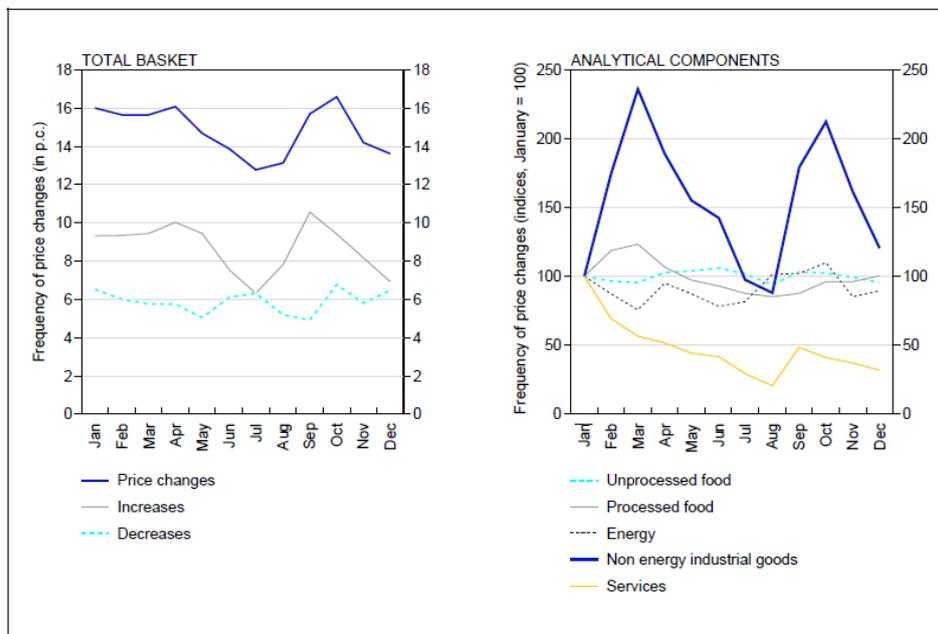
(Table 7, Gouvea, 2007)

In conclusion, prices in Brazil are more flexible which represents less rigidity. In addition, evident heterogeneity could be seen on the price adjustment behavior across different sectors.

Special Cases

Apart from the regularities found among different kinds of countries, some special elements, concerning the seasonality and holidays price changes, also exist. According to the investigation by Aucremanne and Dhyne (2004), there is some evidence of seasonal pattern representing the price changes frequency. Their empirical evidence in Belgium are shown in figure 2 below in detail.

Fig 2 Seasonal pattern of the frequency of price changes¹



Sources: FPS, NBB.

¹ The seasonal patterns are computed as simple averages, excluding the months affected by VAT rate changes (April 1992, January 1994 and January 1996).

(Figure 2, Aucremanne and Dhyne, 2004)

After excluding the value added tax, Figure 2 demonstrates that the quantity of price changes peaks at almost 16 times per month for the total basket from January to April and from September to October. In terms of the classification of price increases and decreases, the former is more obviously affected by seasonal trend than the latter, because the summer and winter sales are excluded in order to capture the pure seasonality feature. Besides, among various commodities, the impacts on non energy industrial goods and services are more evident, which reveals relatively high seasonal price flexibilities.

In the aspect of holidays, Levy et al. (2010) state that the price changes of the Thanksgiving-Christmas period in the U.S. is less frequent. This statement can be shown in table 8 below. It demonstrates that for most categories, the average quantity of retail price changes is lower in holidays. The explanations mainly focus on the menu costs. First of all, shops or supermarkets become more popular during holidays and the opportunity cost faced by retailers of changing prices peaks at that time. Secondly, the labor cost of extra hiring hour also induces a less price change frequency.

AVERAGE NUMBER OF RETAIL PRICE CHANGES PER STORE PER WEEK DURING THE HOLIDAY AND NON-HOLIDAY PERIODS

Product category	Non-holiday	Holiday	% difference	t-statistic
Analgesics	12.38	10.47	- 15	- 1.59 ^c
Bottled juices	26.21	22.10	- 16	- 1.72 ^c
Cereals	21.41	14.07	- 34	- 2.79 ^a
Cheeses	45.72	43.05	- 6	- 0.75
Crackers	14.51	12.46	- 14	- 1.01
Canned soups	27.45	27.89	2	0.18
Dish detergents	11.05	10.52	- 5	- 0.47
Frozen entrees	53.60	34.18	- 36	- 5.98 ^a
Frozen juices	16.98	15.60	- 8	- 0.86
Fabric softeners	10.36	8.01	- 23	- 2.16 ^a
Laundry detergents	17.26	13.99	- 19	- 2.23 ^a
Paper towels	7.15	5.49	- 23	- 2.12 ^b
Refrigerated juices	18.40	16.42	- 11	- 1.61 ^c
Soft drinks	117.83	109.84	- 7	- 1.53 ^c
Snack crackers	24.07	31.07	29	2.21 ^a
Canned fish	13.32	11.05	- 17	- 15.1 ^a
Toothpastes	18.8	15.5	- 18	- 1.33 ^c
Toilet tissues	8.75	6.74	- 23	- 2.25 ^a
Total	465.25	408.45	- 12	- 4.72 ^a

Retail prices are the actual transaction prices, as recorded by the store scanners. The prices are changed at the weekly frequency, which is standard retail food industry practice. As the holiday period in each year, we define the week before Thanksgiving through the week of Christmas, a total six-week period. The remaining weeks are defined as non-holiday periods. Superscripts *a*, *b* and *c* indicate statistical significance at 1, 5 and 10%, respectively.

(Table 8, Levy et al., 2010)

Conclusion

After examining through the evidence on price behaviors in both developed and developing countries, there is no explicit conclusion. To roughly conclude, the developed countries possess more rigid price behavior in respond to economic shocks. On the contrary, the price in developing countries would behave more flexible to the economic shocks. It is worth noting that there exist predominant pronouncing inflation within the developing countries in our developing evidence. These could possibly be the reasons explaining the disparity among the two groups.

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