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Some Facts on Price Rigidity: Case of Slovakia

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Abstract

In this paper we empirically estimate the price-setting patterns of final goods and services at the store level in the Slovak republic. We have obtained several results: first we find that on average one third of prices change in a given month which indicates faster price changes than is typical for both the euro-zone and the U.S. Second, frequency of price changes varies across products, with very frequent changes for Unprocessed Food and least frequent for Services. What is more, where price increases are frequent, price decreases are frequent, too and vice versa. Third, price decreases are not uncommon. Fourth, price increases and decreases are sizable compared to the prevailing inflation rate. Additionally, where price increases are sizable, price decreases are sizable, too and vice versa. Finally, price changes do not seem to be highly synchronized across price-setters.

Keywords: price duration, price changes, price setting

1 Introduction

In this paper we empirically estimate the extent of price rigidity in the Slovak store-level consumer prices. Originally, most of the papers dealing with price rigidity considered specific products and thus this research was limited.¹ However, several studies appeared recently which are better suited to judge the actual extent of price rigidity on a complex set of data. These studies, using large data sets, were also inspiration for this paper.²

First studies in this area typically presented the reader with evidence that price stickiness is significant. Cecchetti [3] collects data at 38 news-stands for a period of around 25 years and presents evidence that magazine prices change once in 1.8-year period to more than ten-year period. Similarly, Kashyap [9] reports that price changes of mail-order catalogue goods are unchanged for a period slightly more than a year. Similarly, Bils and Klenow [2] use a large individual-price data from the US Bureau of Labor Statistics to find that for about a half of

¹Studies which dealt with specific product price rigidity issues include among others Cecchetti [3], Genesove [8], and Eden [5].

²These studies include Bils and Klenow [2] for the United States and studies in the framework of Eurosystem Inflation Persistence Network for Europe, see for example Dhyne et al. [4], and Alvarez et al. [1].

their data prices do not change for more than four months. Additionally, their results pointed to significant differences in the frequency of price changes across different goods.

Until recently such studies have been relatively rare in Europe. Based on the initiative of the Eurosystem Inflation Persistence Network most of the euro-area countries analyzed their country’s respective price stickiness. This research is summarized in Dhyne et al. [4]. In the context of transition economies this topic is dealt with in Gabriel and Reiff [7]. Similarly to these studies, the aim of this paper is primarily to characterize the average frequency and size of price changes in Slovak stores, and compare these results with the results of euro-zone and the U.S results.

2 Description of the Data

We use data set provided by the Slovak Statistical Office (SSO). It contains four-dimensional panel data and is used by the Slovak Statistical Office for computing the national consumer price index. It covers all the Slovak CPI products and spans from 1997 till 2006 with monthly frequency. For our purposes in this paper we only use the span from February 2004 till December 2006 as only this part contains a clear store identifier. This way we get a total number of 3.078.136 observations. We structure these data according to the Classification of Individual Consumption by Purpose (COICOP) groups as collected by the SSO and shown in Table 1.

General Category (COICOP group)	Weight in Total CPI	Number of Products	Regulated Prices
1 Food and non-Alcoholic Beverages	158.032	137	0
2 Alcohol Beverages and Tobacco	45.219	12	0
3 Clothing and Footwear	43.610	97	0
4 Housing, Water, Fuels	282.971	45	19
5 Furniture, House Equipment	54.189	85	0
6 Health Services	25.729	39	39
7 Transportation Services	94.818	73	19
8 Postal Service and Telecom.	37.152	21	12
9 Recreation and Culture	79.864	75	2
10 Education	15.134	7	4
11 Hotels and Restaurant	69.452	44	5
12 Other Goods and Services	93.830	71	13
Total	1000.000	701	113

Table 1: Product Categories in 2006

From the total of 701 goods and services 113 are collected centrally; the main portion of prices is collected in a decentralized way – from 38 major Slovak districts. Each product is collected in three stores on average in each location, altogether in around 13.400 stores over the whole country. This adds up to approximately 90.000 observations per month.

Each individual observation consists of information on the product code, the year and the month, the store identifier and the price; these data do not contain the brand of the

product. For the purposes of ready comparison with the results of Dhyne et al. [4] we clean our database of products with regulated prices and pick 47 products in such a way that they are identical or as much as possible similar to those used in the referenced study. For the list of the products refer to the Table 2.

General Category	Dhyne et al. (2006)	Our Categories
Unprocessed food	steak fresh fish lettuce banana	steak fish filet onion banana
Processed food	milk sugar frozen spinach mineral water coffee	milk sugar frozen spinach mineral water coffee
Energy products	Gasoline for heating two types of fuels	Gasoline (regulated price) Brown Coal (available at fewer locations), Energy
Non-energy industrial goods	Socks, jeans, sport shoes shirt, acrylic paint, cement, toaster, electric bulb one type of furniture, towel, car tire, television set, dog food tennis ball, Lego box or equivalent, toothpaste, suitcase	Socks, jeans, sport shoes shirt, acrylic paint, cement, iron , electric bulb table towel, car tire, television set, dog food volley ball , Lego box or equivalent, toothpaste, suitcase
Services	Dry cleaning hourly rate of electrician hourly rate of plumber domestic services hourly rate in 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-dogr coca-cola or equivalent in a bar men's haircut ladies' hairdressing	Dry cleaning hourly rate of electrician hourly rate of painting apartment a key duplicate hourly rate for change of brakes car wash balancing of wheels taxi, movie DVD 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

Table 2: Comparison of Slovak-Sample Products with Dhyne et al. [4] (bold letters indicate products chosen to be similar to those used in the referenced study)

3 Methodology

We denote time period as t , product as k , and locations as i , and j . Then, $P_{k,i,t}$ denotes a price quote for a specific product in a specific store at time t . We are able to identify identical stores for an individual product, but not across products.³

We define that the price did not change in two consecutive periods if the store, the product code and the price quote are equal for both periods t and $t + 1$.⁴ A price spell is defined as

³To demonstrate by an example: if milk and toothpaste price is quoted from the same store, the store code is not necessarily the same.

⁴This does not exclude a product's replacement. However, only in rare cases did the SSO replace products without changing the corresponding code: to our knowledge only cigarette brands were changed during the period of consideration.

the continuation of equal price quotes (sequence of price quotes). In this data set SSO does not distinguish a sale from regular price change. Therefore, we consider any sale as a regular price change which terminates a price spell.

4 Slovak Consumer Price Data: Descriptive Statistics

We begin this section with describing the raw price data trajectories. In Figures 1, 2, 3 we present sequence of prices for specific products (*men's haircut*, *gas* and *gasoline*) in one randomly chosen store in one randomly chosen specific district. These trajectories were selected to represent a typical trajectory for services, a regulated product and a highly competitive oligopolistic gasoline market. As can be observed the prices of a service product as well as for a regulated product never decline. On the other hand, though the overall trend for gasoline prices is also upward sloping, price reductions do occur.

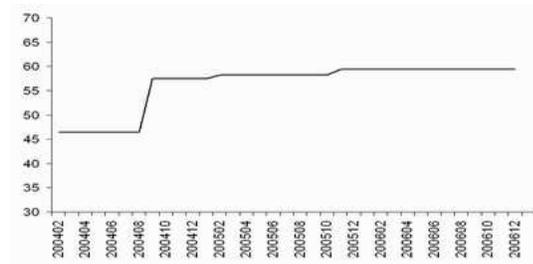


Figure 1: Men's Haircut

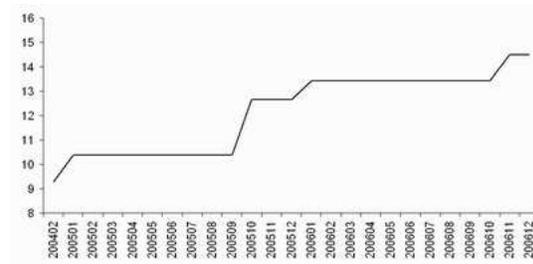


Figure 2: Gas (regulated)

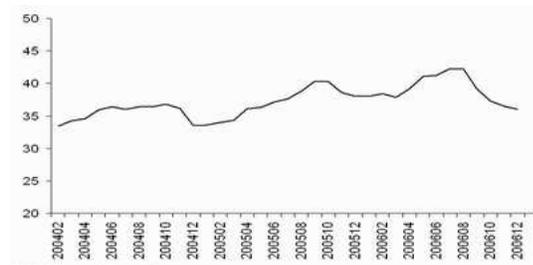


Figure 3: Gasoline

In what follows we present our results using five main indicators as in Dhyne et al. [4] to categorize price changes in Slovakia.

1. the average duration of price spells
2. the frequency of price changes
3. the frequency of price increases and decreases
4. the average size of price increases and decreases
5. the degree of synchronization of price changes

Fact 1: Consumer prices are generally not sticky: the average duration of a price spell in Slovakia is shorter than both in the euro zone and in the United States.

An average of 34.5% prices change in a given month which is higher than the value corresponding to the euro area (15.8%) and the U.S. (24.8%) as presented in studies of Dhyne et al. [4] and Bills and Klenow [2] and shown in the Table 3.

	Slovakia	euro-area	U.S.
Average price duration:			
- inverting methodology	2.9 months	6.6 months	3.8 months
- product category level	6.5 months	13.0 months	6.7 months
Median price duration:	8.6 months	10.6 months	4.6 months
Frequency of price changes:			
- Unprocessed food	56.0 %	28.3 %	47.7 %
- Processed food	33.9 %	13.7 %	27.1 %
- Energy	43.4 %	78.0 %	74.1 %
- Non-energy indst. goods	21.6 %	9.2 %	22.4 %
- Services	12.2 %	5.6 %	15.0 %
- Total	34.5 %	15.8 %	24.8 %

Table 3: Price duration and frequency of price changes

Calculating the duration of an average price spell in a straightforward way (inverting the frequency) yields average duration of 2.9 months. For comparison: this number is 6.6 in euro area and 3.8 in the U.S. However, as several authors had pointed out, this number should be calculated rather indirectly – at the product level. Using this method the spell lasts 6.5 months in Slovakia, 13 months in euro area and 6.7 months in the U.S.

Fact 2: The frequency of price changes varies across products, with very frequent changes for unprocessed food, less frequent for processed food, relatively infrequent for energy and non-energy products and least frequent for services.

Table 3 documents the frequency of price changes across product groups in Slovakia and compares them with the numbers for euro-zone and the United States.

For the United States and the euro zone the frequency of changes across products varies in a similar manner but with slight differences as for Slovakia. In the United States and the euro zone energy prices change with the highest frequency (more than 70% of energy prices change each month) which is not the case in Slovakia due to government regulation of prices of energy products. Common pattern for the three areas can be observed in the following cases: relatively very frequent are changes for unprocessed food, less frequent are changes for processed food and relatively infrequent are changes for services.

Fact 3: Similarly to the euro-zone and the US, there is only small evidence for general downward price rigidity in Slovak data: price decreases are not uncommon, except in energy sector and services. What is more, where price increases are frequent, price decreases are frequent, too and vice versa.

Table 4 indicates that similarly to euro-zone and the US there is little evidence for downward general price rigidity in Slovakia: around one third of price changes are price reductions. Interestingly, in case of non-energy industrial goods the frequency of price decreases is even higher than the frequency of price increases in case of Slovakia.

It can be observed from the Table 4 that where frequency of price increases is higher, frequency of price decreases is higher, too and vice versa. Therefore, we examine the connection between the frequency of price decreases and the frequency of price increases. Figure 4 plots the former against the latter. It demonstrates that there is a tight connection between the two, i.e. high incidence of price increases goes together with high incidence of price reductions.

		Unprocessed food	Processed food	Energy	Non-energy industrial goods	Services	Total
Frequency of price changes	SVK	56.0 %	33.9 %	43.4 %	21.6 %	12.2 %	34.5 %
	EU	28.3 %	13.7 %	78.0 %	9.2 %	5.6 %	15.1 %
	US	47.7 %	27.1 %	74.1 %	22.4 %	15.0 %	24.8 %
Frequency of price increases	SVK	27.1 %	16.7 %	25.8 %	7.8 %	5.7 %	18.7 %
	EU	14.8 %	7.1 %	42.0 %	4.2 %	4.2 %	8.3 %
Frequency of price decreases	SVK	25.0 %	14.1 %	14.1 %	9.5 %	2.0 %	12.1 %
	EU	13.3 %	5.9 %	35.8 %	3.2 %	1.0 %	5.9 %
Share of price increases	SVK	50.6 %	55.7 %	81.1 %	42.0 %	61.6 %	66.9 %
	EU	54.0 %	54.0 %	54.0 %	57.0 %	80.0 %	58.0 %
	US	n.a.	n.a.	n.a.	n.a.	n.a.	55.0 %
Size of price increases	SVK	13.5 %	22.3 %	6.5 %	11.3 %	19.9 %	11.5 %
	EU	14.7 %	6.9 %	3.4 %	9.4 %	7.3 %	8.2 %
Size of price decreases	SVK	11.1 %	10.0 %	5.2 %	10.3 %	13.5 %	8.2 %
	EU	16.3 %	8.1 %	2.4 %	11.4 %	9.7 %	10.0 %
	US	n.a.	n.a.	n.a.	n.a.	n.a.	14.1 %

Table 4: Aggregate results

Fact 4: Price changes are sizable compared to the prevailing inflation rate. Price reductions and price increases have a similar order of magnitude, though price increases are on average slightly larger. What is more, where price increases are sizable, price decreases are sizable, too and vice versa.

Table 4 documents that price changes are sizable compared to the prevailing inflation rate. In the period under consideration inflation rate in Slovakia was very low, not exceeding 3% p.a.

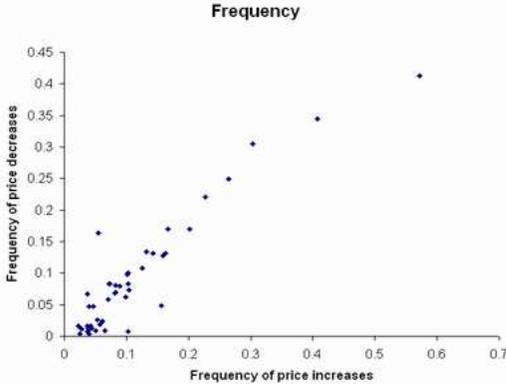


Figure 4: Pooled data – 47 products

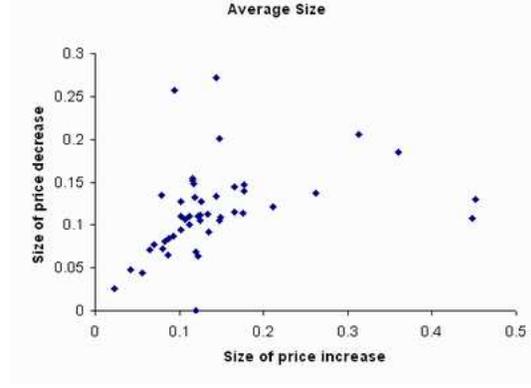


Figure 5: Pooled data – 47 products

Unlike in euro-zone, where on average price increases (8.2%) were smaller than price decreases (10.0%), in Slovak data we find that price increases (11.5%) were higher than price decreases (8.2%) in general but that this also holds for all product categories and services.

It can be observed from the Table 4 that where size of price increases is higher, size of price decreases is higher, too and vice versa. Figure 5 plots the former against the latter. It indicates that the two are positively correlated, i.e. big magnitudes of price increases go together with big magnitudes of price reductions.

Fact 5: Synchronization of price changes across price-setters does not seem to be large at the product level

Following Fisher and Konieczny [6] we construct a synchronization index (SI) for product k according to the following formula:

$$SI_k = \sqrt{\frac{1}{T-1} \frac{\sum_{t=2}^T (f_{kt} - \bar{f}_k)^2}{\bar{f}_k(\bar{f}_k - 1)}}$$

where f_{kt} is frequency of price change of product k at time t and where \bar{f}_k is frequency of price change of product k over time. This index takes a value of one in case of perfect synchronization and zero in the case of perfect staggering.

Table 5 presents the results for the measure of price synchronization in Slovakia. As can be observed, for energy related products the degree of synchronization is highest and it is smallest for the non-energy industrial goods.

The higher synchronization index can be a consequence of the market's size over which the index was computed – there are only three products in the energy-products category and for two of them prices were collected centrally as opposed to numerous market locations in the case of all other categories.

Product category	Weighted index
Unprocessed food	0.223
Processed food	0.254
Energy	0.426
Non-energy industrial goods	0.131
Services	0.197
Total	0.311

Table 5: Synchronization of price changes in Slovakia

5 Future Work

The observed patterns suggest several factors which might be relevant in determining the frequency and size of price changes. As Dhyne et al. [4] pointed out, higher inflation as well as more volatile macroeconomic environment might result in more frequent and/or more sizable price adjustments. Using as dependent variables first frequency of price changes, then frequency of price increases and decreases and finally size of price increases and decreases, Dhyne et al. [4] find that average inflation and its variation have expected effects on these dependent variables. They also find that sectoral effects conform to the observed patterns.

It might be interesting to conduct similar analysis on the Slovak data to see what effects macroeconomic indicators have on Slovak price-setting patterns. However, this goes beyond the scope of this paper and is left for future work.

6 Conclusions

In this paper we empirically estimate the extent of price rigidity in the Slovak store-level consumer prices and compare our results with those from euro-zone and the U.S.

First we find that on average one third of prices change in a given month which indicates faster price changes than is typical both for the euro-zone and the U.S. Second, frequency of price changes varies across products with very frequent changes for Unprocessed Food and least frequent for Services. What is more, where frequency of price increases is high, it is also high for price decreases and analogically for low frequency of price changes. Third, price decreases are not uncommon. Indeed, besides the energy products, over one third of prices changes are price decreases. Fourth, both price increases and decreases are sizable compared to the prevailing inflation rate. Additionally, where price increases are large, price decreases are also large and analogically for small price changes. Finally, using the Fisher&Koniczny synchronization index we find that price changes are not very synchronized across price-setters.

The results presented in this study show that price-setting patterns in Slovakia have some common features with those of euro-zone and the U.S. but at the same time exhibit differences. Intuition for what the underlying sources of these differences might be points towards macroeconomic indicators such as average inflation or its volatility. The effects may also be sector-specific. This is an extension to the current study which is left for future work.

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A Formulas

Denote product as k , location (store) as i and time period (month) as t . Then define the following variables:

A.1 Definitions

- Price observation:
 $P_{k,i,t}$ price in Slovak koronas
- Observation Dummy:

$$OD_{k,i,t} = \begin{cases} 1 & \text{if } P_{k,i,t} \text{ and } P_{k,i,t-1} \text{ are observed} \\ 0 & \text{if } P_{k,i,t} \text{ is observed but } P_{k,i,t-1} \text{ is not} \end{cases}$$

- Price Change Dummy:

$$PCD_{k,i,t} = \begin{cases} 1 & \text{if } P_{k,i,t} \neq P_{k,i,t-1} \\ 0 & \text{if } P_{k,i,t} = P_{k,i,t-1} \end{cases}$$

- Price Increase Dummy:

$$PID_{k,i,t} = \begin{cases} 1 & \text{if } P_{k,i,t} > P_{k,i,t-1} \\ 0 & \text{otherwise} \end{cases}$$

- Price Decrease Dummy:

$$PDD_{k,i,t} = \begin{cases} 1 & \text{if } P_{k,i,t} < P_{k,i,t-1} \\ 0 & \text{otherwise} \end{cases}$$

A.2 Statistical Formulas

- Frequency of Price Changes:

$$FPC_k = \frac{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} PCD_{k,i,t}}{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} OD_{k,i,t}}$$

- Frequency of Price Increases:

$$FPI_k = \frac{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} PID_{k,i,t}}{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} OD_{k,i,t}}$$

- Frequency of Price Decreases:

$$FPD_k = \frac{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} PDD_{k,i,t}}{\sum_{i=1}^{n(i)} \sum_{t=2}^{n(t)} OD_{k,i,t}}$$

- Price Spell Duration:

$$PSD_k = \frac{\sum_{i=1}^{n(i)} \frac{\sum_{t=2}^{n(t)} OD_{k,i,t}}{\sum_{t=2}^{n(t)} PCD_{k,i,t}}}{\sum_{i=1}^{n(i)} OD_{k,i}}$$

- Weight of XX statistics for category c :

$$XX_c = \frac{\sum_{k=1}^{n(k)} w_k XX_k}{\sum_{k=1}^{n(k)} w_k}$$

where w_k is COICOOP weight of product k .