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KONSTANTĪNS BEŅKOVSKIS
LUDMILA FADEJEVA

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THE EFFECT OF VAT RATE ON PRICE SETTING BEHAVIOUR IN LATVIA: EVIDENCE FROM CPI MICRO DATA

CONTENTS

ABBREVIATIONS

COICOP – Classification of Individual Consumption by Purpose
CPI – Consumer Price Index
CSB – Central Statistical Bureau of Latvia
EC – European Commission
EU – European Union
HICP – Harmonised Index of Consumer Prices
VAT – Value Added Tax

ABSTRACT

This paper evaluates the inflation effect of recent VAT rate changes in Latvia by using CPI micro data. Our findings suggest that the pass-through of the tax rate to consumer prices is strong in case of upward tax adjustments, especially when there are no demand restrictions, while the pass-through is weaker for tax reductions. The frequency of price changes peaks at the moment of VAT adjustment, which, however, is partially compensated by lower average size of price revisions. The level of pass-through exhibits a high degree of heterogeneity with higher pass-through for goods, especially food, and lower for services.

Keywords: VAT, inflation, sample selection model, CPI micro data, Latvia

JEL classification: C24, D40, E31, H20

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INTRODUCTION

Changes in indirect tax rates may have significant impact on the short-term inflation outlook. Quantifying the contribution of indirect taxes, however, is not an easy task, as one needs to isolate the tax adjustments from the other numerous supply and demand factors. The access to CPI micro data, however, gives additional information on the effect of indirect tax rate changes. This way, the analyst can directly observe the price response of an individual outlet at the moment of tax revision and afterwards, compare this response with the usual price setting behaviour, make comparisons across different outlets, etc.

The question of VAT impact on inflation is of special importance for Latvia, as there were three major adjustments in the tax rate during the recent years. Standard and reduced VAT rates were increased in January 2009 and January 2011. Later in July 2012, the standard VAT tax rate was reduced. There is no doubt that such revisions in VAT rate have affected inflation in Latvia; however, a mechanical assessment of the impact that is based on the assumption of 100% pass-through of tax changes to consumer prices may lead to wrong conclusions in cases of incomplete pass-through. Therefore, a more comprehensive impact assessment requires an in-depth study. Moreover, Latvia's case is of special interest, as it provides a natural laboratory for exploring the pass-through of indirect taxes in various conditions (sometimes rare, like the reduction of standard rate, or even extreme, like the falling demand at the beginning of 2009).

Therefore, the goal of this paper is to study the effect of recent changes in VAT rate on inflation in Latvia using the CPI micro data provided by the Central Statistical Bureau of Latvia (CSB). These data have already been studied by Beņkovskis et al. (2010, 2012) to discover the price setting behaviour of Latvian firms and check the degree of consumer price rigidities. In this paper, the goal is more focused, although we need to take into account the findings of previous papers, among them relatively high flexibility of Latvia's consumer prices and the mix of time-dependent and state-dependent pricing behaviour. This paper is not unique in addressing the tax rate pass-through question by using consumer price micro data. A recent example is the study by Gábriel and Reiff (2010) on Hungary. Our paper further develops the approaches used in previous empirical studies and provides evaluation of the case of Latvia.

The paper is organised as follows. In Section 1, we outline the main VAT rate changes in Latvia between 2003 and 2012. Section 2 describes the CPI micro database, reviews the main facts about price setting behaviour in Latvia, and makes preliminary analysis of VAT rate pass-through. Econometric analysis is presented in Section 3, which introduces a sample selection model of price changes, explains the choice of explanatory variables, reports the estimation results, and evaluates the overall effect of tax rate changes on inflation. The last section concludes.

1 DESCRIPTION OF MAIN VAT RATE CHANGES

The Council Directive 2006/112/EC of 28 November 2006 on the common system of value added tax[1] provides a legal framework for the application of VAT rates in Member States of the EU in Articles 93 to 130 and Annex III. The basic rules are simple: first, supplies of goods and services subject to VAT are subject to a standard rate of at least 15%; and second, Member States may apply one or two reduced rates of not less than 5% to goods and services enumerated in the restricted list. Member States make wide use of the possibilities offered within this framework; as a result, the system of VAT rates in the EU is in practice disparate and complex.[2] As shown in the situation report on 14 January 2013[3], the minimum standard VAT rate at the time is applied in Luxembourg (15%) and the maximum one in Hungary (27%). The range of the reduced rates in different countries is large, and they vary from 5% to 18%. Latvia is in the middle of the range: VAT rates applied since July 2012 are 21% (standard rate) and 12% (reduced rate).

The standard VAT rate has been revised three times in Latvia, and January 2009, January 2011 and July 2012 can be viewed as the points of major VAT changes (Table 1 presents developments of standard and reduced VAT rate at those dates). At the beginning of 2009, due to severe economic decline and a drop in tax collections, both standard and reduced VAT rates were sharply increased (see Table 1). The standard VAT rate was increased by 3 percentage points (from 18% to 21%) and the reduced VAT rate was raised accordingly by 5 percentage points (from 5% to 10%). Several product groups (e.g. cinema, water, refuse and sewerage collection, solid fuels and accommodation services) lost the privilege of reduced VAT rate (see Table A3) in 2009. Some, e.g. solid fuels and accommodation services, were returned to the list of products with reduced VAT rate afterwards. The second wave of VAT increase came in January 2011, when the standard and reduced VAT rates were raised to 22% and 12% respectively. The only product group that moved from the reduced to standard rate during this period was electricity. The most recent development in VAT rate in Latvia was in July 2012, when the standard VAT rate was lowered by 1 percentage point (from 22% to 21%).

[1] Official Journal of the European Union, L 347, 11.12.2006, p. 1.
[2] http://ec.europa.eu/taxation_customs/taxation/vat/how_vat_works/rates/index_en.htm.
[3] EC document "VAT rates Applied in the Member States of the European Union", http://ec.europa.eu/taxation_customs/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf.

Table 1
Major VAT rate changes in Latvia

January 2009	January 2011	July 2012
Standard rate increase from 18% to 21%	Standard rate increase from 21% to 22%	Standard rate decrease from 22% to 21%
Reduced rate increase from 5% to 10%	Reduced rate increase from 10% to 12%	–
Abolition of reduced rate for several products (from 5% to 21%)	–	–
Effect on inflation under full pass-through assumption (in percentage points)		
3.86	1.27	–0.63

Sources: Law on Value Added Tax of the Republic of Latvia and authors' calculations.
Note: The effect on inflation from VAT change under full pass-through is calculated from HICP and constant tax HICP indices.

However, these were not the only revisions of VAT rate.[4] Also, during the whole analysed period (2003–2012) VAT was not applied to several products (see Table A3 in Appendix). For example, VAT was not imposed on specified medical products and services, dental services, the majority of cultural and educational services, housing rentals, postal services, social protection services, etc.

Changes in the VAT rate could have an important implication for inflation, especially at the moments of standard VAT rate revisions. Under the assumption of full pass-through, the effect can be evaluated by comparing HICP and HICP at constant tax rate indices (see Table 1, the last row). Thus, if all firms had fully passed the tax changes through to prices in January 2009, the inflation would have risen by 3.86 percentage points. The effect on inflation could have been 1.23 percentage points in January 2011. In mid-2012, however, the downward contribution to inflation would have been limited to 0.63 percentage point, as only the standard VAT rate was reduced by 1 percentage point.

2 DESCRIPTION OF DATA AND STYLIZED FACTS

Before turning to the econometric evaluation, we need to describe the CPI micro database used in calculations and explain the adjustments made to the data. Micro data is a very rich source of information, thus even preliminary analysis of it can give useful insights into the VAT rate pass-through to consumer prices.

[4] In May 2004, as Latvia became a member of the EU, the reduced VAT rate for several product groups, such as newspapers and periodicals, accommodation services, water, refuse and sewage collection, some medical products, decreased from 9% to 5% (there were two different reduced rates prior to accession). On the other hand, VAT rates increased from 0% to 5% for some products, such as books and cinema. From the beginning of 2005, the reduced VAT rate was applied to passenger transport by road and railway. Since 2007, the reduced VAT rate application has widened to include electricity and natural gas consumption by households previously exempted from VAT. For a short period (January 2007–December 2008), the reduced VAT rate was also applied to solid fuels and hairdressing services. Heat energy is the only product group, for which VAT rate increased during the period 2006–2007 (July 2006) from 0% to 5%. Table A3 in Appendix provides a more detailed description of non-standard VAT rate changes for several products since 2003.

2.1 CPI micro database

The database used in the current research is provided by the CSB and is generally used as a part of the database for Latvia's CPI. The sample contains partially anonymous 6-digit COICOP records for prices of individual products (only 4-digit COICOP level is known) in a particular outlet at monthly frequency from January 2003 to December 2012. The total number of records is 796 080 for 181 products. There are 6 634 individual product-outlet pairs with 4 to 71 outlet records per individual product every month (36.7 outlet records per product on average).

According to the confidentiality restrictions, the database used in this research does not contain data on products for which prices from a very limited number of producers or outlets are available. Also, data on administered prices are excluded. Therefore, the sample does not cover all products (see Table A1 in Appendix). We have detailed information on 42% of the CPI basket in 2012, with higher coverage for food, alcoholic beverages and tobacco (above 60%), and lower coverage for services. Despite that we are still able to produce a reasonably good proxy for the annual rate of official annual inflation from this data (see Figure A1 in Appendix). CPI approximation herein mimics the official inflation, capturing the increases in 2007 and early 2008, a sharp decrease in late 2008 to early 2010, and subsequent moderation. The only striking feature of this approximation is a permanent overestimation within the range of 3–5 percentage points. It is driven by the low coverage in services, primarily the absence of data on telecommunication service prices which were permanently decreasing during the observed time period.

In addition to price levels, the database provides information on two types of specific data issues: first, cases when a product is replaced by another similar product and, second, cases when the data point is estimated rather than observed (imputations). Product replacement almost always contains a shift in the price level, which, however, is not informative. Thus, we ignore the price change at the moment of replacement. Imputations are used by the CSB in the case of short-term absence of product in an outlet (for a period less than 2–3 months) or for seasonal products (the price is not posted year-round). It is done by extrapolating the data series based on dynamics of other observable products in the respective price group.[5] Price imputations might result in a biased frequency of price changes (especially for seasonal products), therefore we ignore imputed prices.

[5] Detailed description of the importance of price imputations in the database, including the role of price imputations by COICOP groups and main categories, can be found in Beņkovskis et al. (2010).

2.2 Main characteristics of price setting behaviour in Latvia

The main indicators that describe the price formation mechanism are frequency and size of price changes. Both indicators are presented in Table 2. Frequency of price changes is calculated using the frequency approach.[6] The results demonstrate that each month during 2003–2012, 24.7% of consumer prices were changed on average, which means that the average duration of a price spell was approximately 4 months.[7] These figures indicate a rather high degree of price flexibility in Latvia, which exceeds the one in euro area countries (between 10.0% and 23.0% for individual countries and 15.8% for euro area; see Dhyne et al. (2005)) and is roughly equal to price flexibility in the US (24.8%; see Bils and Klenow (2004)).

Table 2

Frequency and average size of price changes by COICOP group and main economic category (2003–2012)

	Frequency	Average price change
1 Food and non-alcoholic beverages	32.0	3.0
2 Alcoholic beverages, tobacco	23.8	2.1
3 Clothing and footwear	9.7	–3.7
4 Housing, water, electricity, gas and other fuels	13.1	3.6
5 Furnishing, household equipment, etc.	14.0	1.4
6 Health	12.8	5.7
7 Transport	49.2	0.7
8 Communication	28.4	–5.9
9 Recreation and culture	12.8	2.7
10 Education	5.8	1.7
11 Restaurants and hotels	7.1	5.4
12 Miscellaneous goods and services	15.9	4.0
Food	32.0	3.0
Energy	75.0	1.7
Non-energy goods	16.2	0.7
Services	5.7	5.7
Total	24.7	2.2

Sources: CSB and authors' calculations.
Notes: Frequency shows the average share of prices that are changed during one month, %; average price changes show the average changes of prices, %.

Frequency figures are not homogenous for different types of products. According to Table 2, the highest flexibility (lowest duration) is observed for transport (49.2%), food and non-alcoholic beverages (32.0%), communication (28.4%), and alcoholic

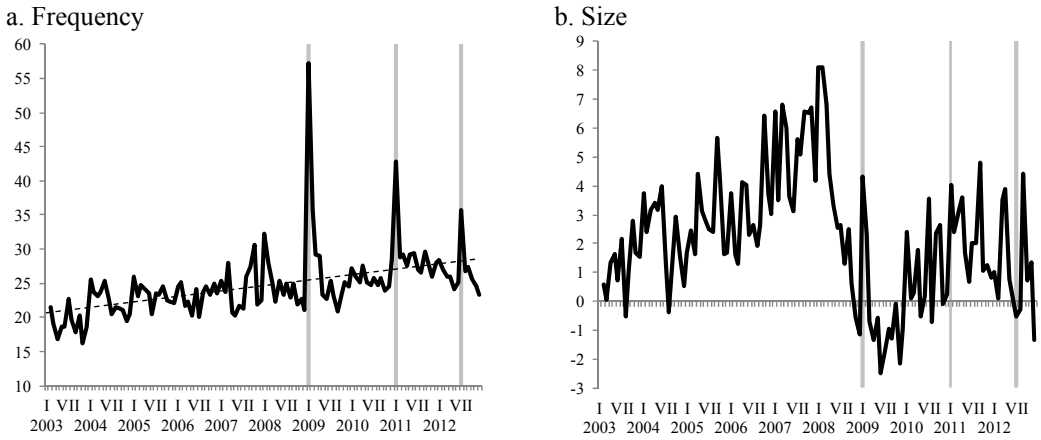
[6] More details on how frequency of price changes are calculated and how frequency approach differs from duration approach can be found in Bils and Klenow (2004), and Aucremanne and Dhyne (2004). The results for individual products were aggregated using product weights in the CPI basket. As coverage of the CPI micro data is below 100%, the weights of existing products were adjusted to get the total sum of weights equal to 100%. The adjustment was done on the most detailed disaggregation level (usually 3- or 4-digit COICOP level) taking into account the consumption basket weights provided by the CSB of Latvia.

[7] Beņkovskis et al. (2010) report that the frequency of price changes was 28.7% and the duration was approximately 3.5 months in 2003–2009. Although Beņkovskis et al. (2010) use the same CPI micro database, these results are not directly comparable with those reported in Table 2, as the current paper ignores price imputations. The difference mainly comes from decreased frequency of price changes in clothing and footwear.

beverages and tobacco (23.8%). However, we should take into account that the results for transport and communication are biased due to sample problems (see Table A1 in Appendix). The high flexibility of transport prices is attributed to fuel, while the purchase of vehicles and transport services were underrepresented in the database. A similar problem occurs in communication, as we have no data on postal and telephone services. The lowest flexibility is obtained for education (5.8%), restaurants and hotels (7.1%), clothing and footwear (9.7%), and health (12.8%). Although there are severe sample problems with the education and health prices, it could be argued that the duration of 8–17 months is quite natural for those education and health services which are missing in the database. As to clothing and footwear, the low flexibility is driven by the exclusion of price imputations.[8] If we look at price flexibility by economic category, we observe price flexibility of the highest degree for energy products (75.0%, mainly due to motor fuels) and food (32.0%), while the highest rigidity is typical for services (5.7%).

Along with the frequency that characterises price flexibility, the size of price changes is also an important feature of price formation. The average consumer price change in 2003–2012 was 2.2%, although this indicator differs across groups as well. For instance, the largest changes are observed for health (5.7%), and restaurant and hotels (5.4%), while the average change for communication as well as clothing and footwear prices was even negative (–5.9% and –3.7% respectively). Overall, there is a tendency of larger price changes for groups with the smallest frequency of price changes.

Figure 1
Frequency and size of price changes over time for all prices (2003–2012)



Sources: CSB and authors' calculations.
Notes: Frequency shows the average share of prices that are changed during one month (%); size of price changes show the average logarithmic changes of prices (%). Periods of standard VAT rate revisions are marked in grey.

Obviously, the price formation behaviour can change in the course of 10 years. Figure 1 shows a continuous time-line for frequencies and sizes of price changes during 2003–2012. In 2003, the frequency of price revisions was slightly below 20%, while in 2011–2012 it exceeded 25%. The increase over time was rather

[8] Beņkovskis et al. (2010) report 26.0% frequency of price changes for clothing and footwear during 2003–2009, including price imputations.

steady, although there were several noticeable spikes corresponding to the major changes in VAT rate. In January 2009, when the standard rate of VAT increased by 3 percentage points, the frequency of price changes peaked to almost 60%. The next increase of the standard rate by 1 percentage point occurred in January 2011, and the frequency of price revisions exceeded 40%. The last spike coincides with a decrease of the standard rate by 1 percentage point in July 2012, when the frequency of price changes was close to 35%. Just a simple comparison of these numbers shows the importance of the size of VAT adjustment and possible asymmetry in the reaction to tax increases and decreases.[9]

The other aspect of price setting that could alter in the case of VAT rate revision is the average size of price changes, reported in Figure 1b. Overall, the average size of price changes follows the dynamics of total inflation – a gradual increase until the beginning of 2008, when the average size of change reached 8%, then a sharp decline with a bottom achieved in mid-2009 and a negative average price increase of approximately –2%. Finally, in 2010–2012, the average size of price changes fluctuated around 1.5%–2%. As to the specific dates of our interests, the average size of price changes in the cases of VAT increase (January 2009 and January 2011) was slightly above 4%. The similar size of average price increases despite different tax rate enlargements (3 times higher in 2009) may reflect the weak demand in 2009. The asymmetry in reaction to tax increase and decrease is observed for the size of price changes as well: the average price decrease was only 0.5% in July 2012.

2.3 More evidence on VAT rate effect

The facts above, although giving a clue to the overall effect of VAT changes on inflation, are clearly not sufficient for any conclusion. This subsection provides more detailed analysis by looking at the cases of price decrease and increase separately and accounting for different reactions across product groups.

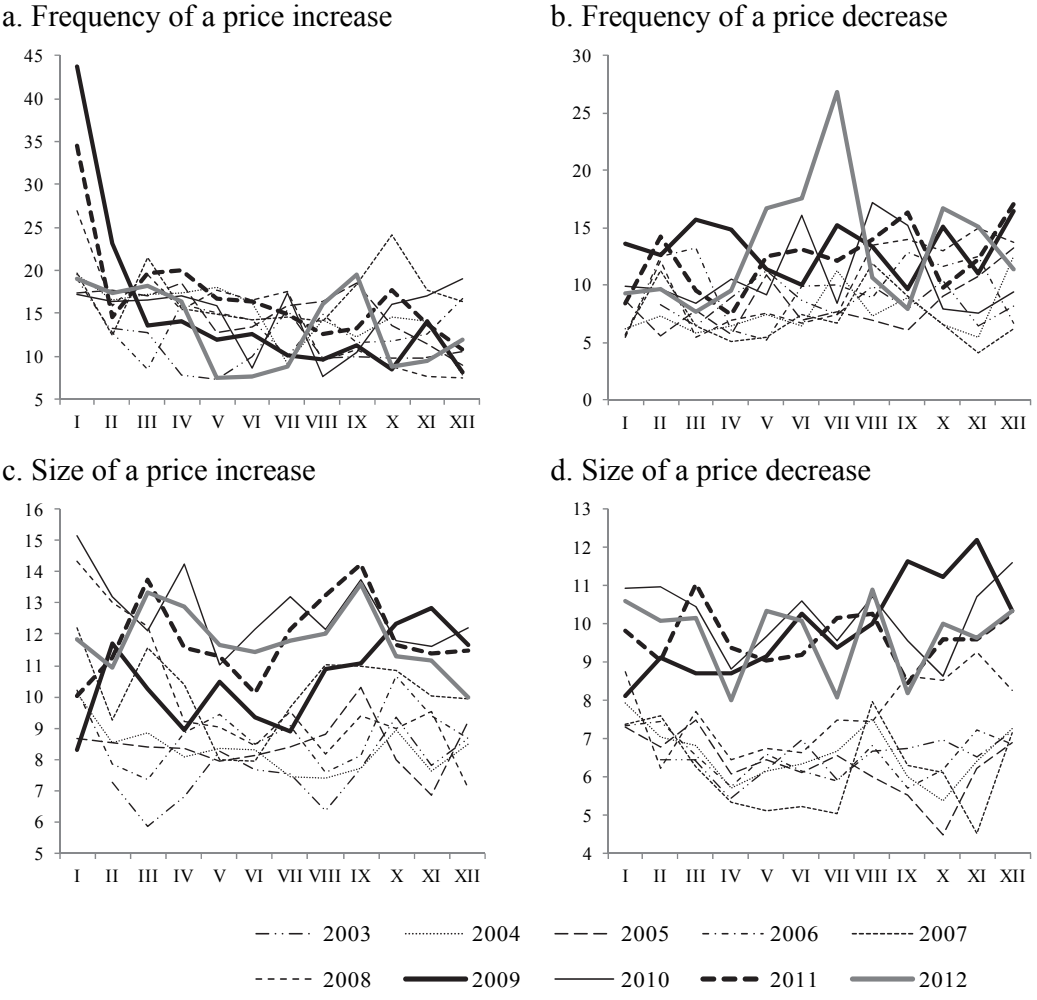
First, we can look at the average frequency and size of overall price changes by year (see Figure 2). Such representation allows taking into account seasonal factors, which could be very important for price formation behaviour. Moreover, Figure 2 reports upward and downward price revisions separately. The bold lines represent the years of our specific interest: 2009, 2011 and 2012. A pronounced effect of VAT rate increase is observed in Figure 2a, as the frequency of price increases in January 2009 and January 2011 is clearly above the normal seasonal pattern. Unusually high frequency of price increases is observed also in February 2009. It was, however, mostly driven by raised excise tax on alcoholic (spirits, wine, beer) and non-alcoholic beverages (coffee, soft drinks). On the other hand, the reduction of VAT rate in mid-2012 did not have any major effect on the proportion of price increases. Although the frequency was below the normal seasonal pattern, 8.8% of all prices were still raised in July 2012, which is close to the numbers observed in July 2004 and July 2007.

[9] Some evidence on such asymmetry in price setting behaviour was found in Benkovskis et al. (2012), as a VAT rate increase by 1 percentage point increased the probability of a price change by 8.9 percentage points, while a VAT rate decrease by 1 percentage point increased the probability of a price change only by 1.4 percentage points. However, these results were obtained for 2003–2009, when there was no decrease in VAT rates (the rate reduction was observed for several products due to the switch from the base group to a reduced rate group).

Frequency of downward price revisions is reported in Figure 2b. Two important conclusions can be made here. First, despite a sizeable increase of VAT rate in January 2009, the frequency of price reductions exceeded the usual seasonal pattern, as almost 15% of prices were revised downwards. This was driven by a combination of weak demand and decrease of prices for several imported products (e.g. fuel). Second, the frequency of price decrease reached its historical maximum in July 2012 (26.8%), which was still below the frequency of upward revisions in the periods of raised VAT rate. Interestingly, the frequency of price decreases had been higher than usual already two months before the VAT rate reduction. This, however, is explained by price reductions in fuel and alcoholic beverages (beer) and was not related to the forthcoming adjustment in the tax rate.[10]

Figure 2

Frequency and size of positive and negative price changes over time for all prices (2003–2012)



Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); size of price changes show the average changes of prices (%).

[10] In the case of fuel, a more frequent price reduction was obviously driven by the decreasing world price of oil. Lowering of beer prices was most probably due to weather conditions, for the relatively cold summer diminished the demand for beer.

To get a full picture of changes in the price setting behaviour, a similar analysis for the average size of price revisions is required. Figures 2c and 2d show the tendency for the size of price revisions to become larger in the later years. This is especially pronounced for the average size of price decreases which fluctuated around 5%–7% before mid-2008 and went up to 9%–12% afterwards. As to the effect of change in VAT rate on the size of price adjustments, it works in the opposite direction compared to the effect on the frequency of price changes.[11] The average size of upward price revisions was lower than usual in January 2009 and January 2011. The same can be said about July 2012 when the average size of price decreases was lower compared with the respective month during 3 previous years. This seems to be contradictory at a first glance. This paradox can be explained by the fact that the sizes of VAT rate revisions were by far lower than the average size of usual price adjustments. As a result, the larger fraction of outlets revising their prices due to the new tax rate lower the size of price changes in a particular month. Consequently, the VAT rate revisions led to higher frequencies of price adjustments, which were partially compensated by smaller price revisions.

Similar analysis can be carried out on a more disaggregated level. To account for different price setting across products, we formed 14 groups of goods and services. This classification is further used in descriptive and econometric analysis. The split was made accounting for the number of product-outlet pairs, the importance in the CPI basket (accordingly important product categories with good coverage, like food, were divided into several subgroups), and similarities in price formation behaviour in terms of frequency and size of price changes.[12] As a result, food products and non-alcoholic beverages were divided into 6 groups. Alcohol and tobacco, clothing and footwear, furnishing and household equipment products, fuel, communication, recreation and culture products were separated from the other goods. Services were divided into 2 groups: restaurants and hotels, and other services. The list of groups is reported in the Table A2 in Appendix.

Indeed, the analysis on disaggregated level reveals a lot of heterogeneity in reaction to VAT rate changes (see Figures A2–A15 in Appendix). The differences in behaviour are less pronounced for tax rate enlargements: the proportion of positive price revisions in 2009 and 2011 exceeds the usual pattern observed in January for all groups, except fuel as well as fruits and vegetables. The frequency of price increases was much higher for food products (with exception of fruits and vegetables), while the immediate impact of an increase in VAT rate was weaker for other goods and services (especially clothing and footwear products). At the same time, the frequency of price decreases in January 2009 and January 2011 was still relatively high for most product groups.

Even more heterogeneity can be found in the response to VAT rate reduction in July 2012. The highest frequency of price decreases in that particular month was observed for meat and fish (almost 45%), milk, cheese and eggs, non-alcoholic beverages (more than 30%), and other food products (25%). For some groups the effect was not significant, e.g. the high proportion of price decreases for fruits and vegetables was solely driven by seasonal factors. The same was observed for

[11] Gábriel and Reiff (2010) report a similar effect for VAT rate changes in January 2004, January 2007 and September 2006 in Hungary.
[12] For main characteristics of all individual products see Beņkovskis et al. (2010).

clothing and footwear products, restaurants and hotels. Several groups had a pronounced peak in the frequency of price decreases; however, the level of this peak was low, e.g. for other services the proportion of price decreases achieved just 12%, while for communication, recreation and culture products it was 15%. These results confirm the initial intuition that the pass-through of VAT rate reduction was low both in absolute terms and in comparison to the pass-through of the increase in VAT rate.

Another important aspect is the lagged effect of change in VAT rate on the size and frequency of price adjustment. Despite the potential impact on the frequency of price changes in later months, we do not observe it in any of the analysed subgroups. The effect, if existing, is small and cannot be detected, as frequencies of price revisions do not differ from a usual seasonal pattern in periods following the tax rate adjustment.[13] The only exceptions are non-alcoholic beverages and alcoholic beverages and tobacco in February 2009 (due to changes in excise tax), and alcohol and tobacco (mostly beer) in August 2012 (because of the cold summer and diminished demand). Therefore, it seems that the VAT effect on price adjustment is concentrated in the first month, while the lagged effect is very small.

Finally, some words should be said about the VAT effect on the average size of price adjustments. In most cases, we observe a tendency of lower-than-usual size of upward price revisions in the case of raised VAT rate and lower-than-usual size of downward price revisions in the case of lowered VAT rate. As discussed before, the sizes of VAT rate revisions were smaller than the average size of usual price adjustments. That is why the larger share of outlets revising their prices due to changes in the VAT rate reduces the average size of price changes.

3 ECONOMETRIC EVIDENCE

This section studies the immediate pass-through of VAT rate changes on inflation. Here we follow and develop further the methodology used by Gábriel and Reiff (2010) for Hungary.

3.1 Inflation decomposition

Changes in VAT rate can affect inflation by altering the proportion of outlets revising their prices and/or changing the average size of price revision. In addition, the effect can differ for upward and downward price revisions. More formally, the average price change (or inflation) can be decomposed in the following way (for more detail, see Hoffmann and Kurz-Kim (2006)):

$$\pi = p^{+}\mu^{+} + p^{-}\mu^{-} \quad (1)$$

[13] This observation is also approved by later econometric investigation. Coefficients before lagged VAT variables were not statistically significant in equations for size and probability of price changes.

where π is the average price change, p^+ and p^- are the shares of outlets revising prices upwards and downwards, μ^+ and μ^- are the average sizes of upward and downward price revisions.[14] Gábriel and Reiff (2010) propose to quantify the VAT rate effect on inflation:

$$\left(p^{+VAT}\mu^{+VAT} - p^{+}\mu^{+}\right) + \left(p^{-VAT}\mu^{-VAT} - p^{-}\mu^{-}\right), \tag{2}$$

where p^{+VAT}, p^{-VAT}, μ^{+VAT} and μ^{-VAT} are frequencies and average sizes of price changes respectively, including the effect of VAT rate revision, while p^+, p^-, μ^+ and μ^- represent changes that could be expected in the case of constant VAT rate. In order to apply equation (2), we need to formulate a model that will, first, describe the probability of a price revision (p) and, second, estimate the expected size of a price revision (μ).

3.2 Sample selection model of price changes

The probability of a price change can be obtained by a simple binary model (see, e.g. Aucremanne and Dhyne (2005), Lünnemann and Mathä (2005), Baumgartner et al. (2005) and Baudry et al. (2007)). However, explaining the size of a price revision is not so straightforward. The desired price change is a latent variable, as rigidities do not allow firms to adjust prices every period. As a result, we get information on the desired size of price correction only when the correction is actually made. Empirical investigations show that consumer price formation in Latvia is a combination of both state-dependent and time-dependent behaviour (see Benkovskis et al. (2012)), which means that at least some part of Latvian firms do not follow the randomly driven Calvo (1983) price setting mechanism. We have a classical case of an incidental truncation. The data on the size of a price change is non-randomly selected, and one could expect left truncation, e.g. due to the fact that the desired price changes are below the menu costs and, therefore, will not be observed. Consequently, the average size of observed price changes is a misleading indicator of the size of desired price change.

To account for incidental truncation, we should use a sample selection model. Following the notation of Green (2002), a sample selection model for the size of price change can be formulated in the following way.

The selection equation can be written as follows:

$$z^*_{ijt} = w^T_{ijt}\gamma + u_{ijt},\ z_{ijt} = 1 \text{ if } z^*_{ijt} > 0 \text{ and 0 otherwise;}$$

$$\Pr\left(z_{ijt} = 1 \middle| w_{ijt}\right) = \Phi\left(w^T_{ijt}\gamma\right) \tag{3}$$

where z_{ijt} is [ijt x 1] binary vector, which equals 1 when the price of product i in outlet j was changed in the period t. w_{ijt} is [ijt x k] matrix of k variables that determine the probability of price change, while γ is the vector of parameters. $\Phi(.)$ denotes the standard normal cumulative distribution function.

[14] Hoffmann and Kurz-Kim (2006) use the average size of log-changes while defining μ^+ and μ^-, as they proxy German CPI by a geometric Laspeyres formula. Taking into account that Latvia's CPI is calculated using an (arithmetic) Laspeyres formula, we define μ^+ and μ^- as a simple growth rate. Note that μ^- is always negative.

The outcome equation can be written as follows:

$$y_{ijt} = x_{ijt}^{T}\beta + \varepsilon_{ijt} \text{ observed only if } z_{ijt} = 1, \quad (4)$$

$$\left(u_{ijt}, \varepsilon_{ijt}\right) \sim \text{bivariate normal } [0, 0, 1, \sigma_{\varepsilon}, \rho]$$

where y_{ijt} is [ijt x 1] a vector describing the size of desired price change for product i in outlet j in the period t, while x_{ijt} is [ijt x n] the matrix of n variables that determine the desired size of price change. β is the vector of parameters, u_{ijt} and ε_{ijt} are the error terms that have a bivariate normal distribution with zero means and correlation ρ.

Taking into account that y_{ijt} is observed only when the price is changed ($z_{ijt} = 1$), while z_{ijt} and w_{ijt} are observed for all product-outlet pairs in all periods, the model transforms into:

$$E\left(y_{ijt} \middle| z_{ijt} = 1, x_{ijt}, w_{ijt}\right) = x_{ijt}^{T}\beta + \rho\sigma_{\varepsilon}\lambda\left(w_{ijt}^{T}\gamma\right) \quad (5).$$

The second term in equation (5) is the correction of selection bias and $\lambda(.)=\phi(.)/\Phi(.)$ where $\phi(.)$ is a standard normal probability distribution function.

It should be noted that the set of factors determining the probability of price change (w_{ijt}) and the size of price change (x_{ijt}) can differ. The factors determining frequency of price change (w_{ijt}) are analysed first. In this paper, we follow (although with some modifications) the list of variables used in Benkovskis et al. (2012) to explain the probability of price changes in Latvia, and the set of variables used herein significantly exceeds the one used in Gábriel and Reiff (2010).

The effect of VAT rate changes on frequency of price adjustments is captured by two variables, i.e. positive and negative VAT rate changes (*VAT_plus, VAT_minus*). Both variables are calculated as $(1+VAT\_rate_t)/(1+VAT\_rate_{t-1})$. The split between positive and negative changes is aimed at capturing the asymmetric reaction to VAT adjustment, reported in Benkovskis et al. (2012). In addition, we include the square of positive VAT rate changes to assess possible non-linear effects.[15] Several products (alcohol, tobacco, coffee, soft drinks) are also subject to the excise tax.[16] Although the effect of excise tax on inflation is not in the focus of the current research, we need to take changes in excise tax rate into account and do it by including excise tax dummy variables.

According to Cecchetti (1986), the accumulated inflation since the last price adjustment should be among the explanatory variables under the state-dependent pricing assumption, since larger accumulated inflation is associated with shorter duration between price changes. We include two measures of accumulated inflation since the last price change at different levels of aggregation: the first is accumulated inflation at the corresponding 2-digit COICOP level (π_group), and the second is overall accumulated inflation (π_total). An important difference from Benkovskis et al. (2012) is that the current paper uses accumulated inflation calculated from HICP at constant tax rate. The effect of changes in indirect tax rates is already accounted for by VAT change variables; therefore, the use of standard inflation will

[15] It can be argued that changes in VAT rate have also a lagged effect on frequency (and size) of price changes. However, we did not find statistically significant effects of lagged VAT variables. Thus, these were excluded from our model.

[16] For more details on excise tax rates for selected products, see Table A4 in Appendix.

underestimate the tax rate pass-through.[17] Also, Cecchetti (1986) shows the importance of the demand factor for the frequency of price changes. Here we use the overall demand variable, which is defined as the accumulated change in the total retail trade turnover at constant prices since the last price change (*Trade*).

Using the target-threshold model, Cecchetti (1986) proved that the longer the period since the last price change, the greater the probability of observing another price change. On the other hand, Taylor (1980) model assumes the truncation of a price spell after a fixed period of time. To account for these effects, we use two types of time variables. First, we include the logarithm of the period of time elapsed since the last price change ln(*T*). Second, as in Aucremanne and Dhyne (2005), we test for possible price spell truncations as in Taylor (1980) model by including a set of dummy variables (*Dur*1, *Dur*2, *Dur*3, *Dur*4, *Dur*6, *Dur*9 and *Dur*12) which are equal to 1, if the period of time since the last price adjustment is 1, 2, 3, 4, 6, 9 or 12 months respectively.

The frequency of price changes could be affected by psychological effects and marketing strategies. One effect, which is usually included in the models of price setting behaviour, is the effect of an attractive price. Like in Aucremanne and Dhyne (2005), we define the attractive price (*ATP*) as a price ending with digits 0, 5 or 9. The firms are expected to prefer attractive prices to other prices and adjust the former less frequently. In addition, we use dummy variables indicating some specific cases of attractive (or even super attractive) prices that end in 00, 50, 95 and 99 santims (*ATP*00, *ATP*50, *ATP*95, *ATP*99).

Cecchetti (1986) argues that the size of the previous price adjustment may contain information about the next price change. If the previous price change was large, it could indicate that the threshold for changing prices is high and firms are forced to change prices less frequently, although by larger amounts. Therefore, we introduce a variable which shows the size of the previous price change (*LDP*). To account for the possible asymmetries, we distinguish between the cases where the previous price adjustment is positive and the cases where it is negative. This is done by inclusion of a dummy variable (*DW*), which is equal to 1, if the previous price change is negative.

One new variable not used in Benkovskis et al. (2012) is the price level of a product (*P_last*). We expect the frequency of price changes to be positively connected to the price level, as menu costs are relatively smaller for expensive products. Moreover, the prices of very cheap products could be more rigid due to the rounding effect.

The frequency of price changes may display seasonal patterns, captured by a set of monthly dummies (*January*,…, *November*, with December as a baseline month). In addition, the year dummies (*Year*2004,…, *Year*2012, using 2003 as a baseline year) are included to capture changes in the price setting mechanism that are not explained by other factors in the model. Therefore, year dummies can be interpreted as the effect of omitted macroeconomic conditions, e.g. the demand and supply factors.

Variables that affect the size of price adjustment (x_{ijt}) are the subset of (w_{ijt}). Obviously, the outcome equation should include the variables describing changes in

[17] However, it should be noted that HICP of constant rate is calculated assuming immediate and 100% pass-through of all tax rate changes. Therefore, using HICP at constant tax rate could lead to a slightly overestimated effect of tax changes on inflation.

VAT rate and excise tax dummies. Also, following Gábriel and Reiff (2010), we include year and seasonal dummies, as the size of price changes depends on macroeconomic conditions, and for many products it also has strong seasonal pattern (e.g. fruits and vegetables or clothing and footwear). Finally, the desired size of price changes should depend on the accumulated inflation since the last revision. On the one hand, the longer the period since the last revision, the higher the size of changes is expected to be (we observed negative relation between the frequency and size of price adjustments presented in Table 2). On the other hand, year and seasonal dummies are not capturing heterogeneity in the demand and supply conditions for individual products, which, at least partially, is described by accumulated inflation on the group level. Therefore, both cumulated inflation variables are included in x_{ijt}.

3.3 Estimation of selection models

The parameters of selection model in equations (3)–(5) can be estimated by either the maximum likelihood estimator (see, e.g. Amemiya (1985) and Puhani (2000)), or the two-step estimation procedure of Heckman (1979). The latter first estimates the selection equation by probit model and calculates the so-called inverse Mills ratio, which is then included into the least squares regression of outcome equation, thus correcting for selection bias. Although Heckman's estimator (1979) became the most popular way of estimating the selection model, it is a subject of various critical points. First, in the case when x_{ijt} and w_{ijt} coincide, the second-step estimation is only identified through nonlinearity of the inverse Mills ratio. If $w^T_{ijt}\gamma$ does not have much variation in the sample, there could be a severe collinearity among the regressors, which could lead to large standard errors of estimated coefficients (see Puhani (2000) and Wooldridge (2010)). The collinearity problem, however, is not crucial in our case as we apply a list of exclusion restrictions (seeking for variables that affect the selection variable but does not affect the outcome variable directly). For example, attractiveness of a price does not affect the desired size of a revision (as it does not affect costs), while it changes the frequency of price adjustment. A similar argument can be applied to variables describing the time elapsed since the last time of a price revision, or a price level variable. Second, Puhani (2000) states that in the absence of collinearity problem Heckman's estimator (1979) may be used; however, the maximum likelihood estimator is recommended as it is usually more efficient. The inefficiency of Heckman's estimator (1979) comes from the fact that adding the estimated inverse Mills ratio as a regressor results in heteroskedastic error even if the original error term is normal and homoskedastic (see, e.g. Green (2002) and Wooldridge (2010)).

Due to it, we herein estimated the sample selection model using the maximum likelihood method,[18] applying it to 13 out of 14 previously described product groups.[19] In addition, we took into account the weights of products in consumption

[18] According to Wooldridge (2010), the maximum likelihood estimator will be more efficient under joint normality of ε_{ijt} and u_{ijt}, although it is less robust and sometimes has convergence problems.

[19] Estimates were not made for fuel products due to a very specific price setting nature (see Figure A11). Full pass-through of tax shocks was assumed instead.

basket.[20] The positive and negative price changes were estimated separately. The estimation results are shown in Tables A5–A8 in Appendix.

Tables A6 and A8 report the outcome of selection equations, thus describing how abovementioned factors affect the frequency of price changes for different groups. Broadly, the results are in line with Benkovskis et al. (2012). The probability of price change in most groups is driven by macroeconomic conditions, e.g. accumulated inflation on group and aggregate level and trade turnover (the only group unaffected by any of these factors were clothing and footwear products). On the other hand, at least some part of firms use the time-dependent price setting mechanism, adjusting prices after some fixed time period (every 1–4 months for food products and 9–12 months for services). The attractiveness of price in general increases the rigidity (both, upward and downward), although the effect of various types of attractive prices can significantly differ across groups. The level of price positively affects the probability of a price decrease, while, surprisingly, the effect is opposite in the case of upward price adjustments. Year dummies indicate significant differences in macroeconomic conditions during the sample period: in general, a higher probability of price increase during the boom years and a larger chance of price decrease after 2008. All modelled product groups have pronounced (although very different) seasonal effects in frequencies of price changes. Finally, the main variables of interest – VAT rate change variables – have significant effect on the probability of price revisions in the majority of product groups. The only exception is clothing and footwear products, where coefficients before VAT rate changes are insignificant in both equations (this coincides with the preliminary analysis in Figure A9 in Appendix).

The results of outcome equations, describing the desired size of price adjustments, are reported in Tables A5 and A7. Beyond the year and seasonal effects (as before, seasonality is observed in the majority of groups, while the size of revisions has a tendency to increase in the second half of the sample), the desired size of price change is affected by accumulated inflation. Although this effect is not as pronounced as in selection equations, higher inflation generally leads to larger upward and lower downward revisions. The changes in VAT rate have a significant effect on the desired size of price change in most of the cases, with an exception of alcohol and tobacco. Another important result is the estimates of ρ, e.g. correlation between errors in selection and outcome equations. In almost all the cases, correlation is statistically different from zero, which means that the estimation of output equation by least squares would lead to biased results, and the choice of sample selection model is justified.

3.4 Estimated effects of VAT rate changes

Although the results in Tables A5–A8 are informative, it is still difficult to draw any conclusion about the size of VAT rate effect on inflation from the model coefficients alone. Instead, the estimated models might be used to obtain p^{+}, p^{-}, μ^{+}, μ^{-} and p^{+VAT}, p^{-VAT}, μ^{+VAT}, μ^{-VAT} for each product group, and then to calculate the overall effect of VAT on price changes for each product using equation (2). Product effects can be later aggregated using the sample weights.

[20] See Footnote 6 in Subsection 2.2 describing the procedure used to adjust product weights.

By using estimated sample selection models, one can make an in-sample forecast for the probability of price change, and the desired size of price revision, given that the price is changed. The forecast is made for each product separately (using estimation results of the respective equation) calculating the average expected probability and the size of price change for an average outlet. The forecasts for cases of upward price revisions were made as follows, using the results reported in Tables A5 and A6[21]:

$$p_{it}^{+VAT} = E\left(z_{it} \middle| \overline{w}_{it}\right) \text{ and } \mu_{it}^{+VAT} = E\left(y_{it} \middle| \overline{x}_{it}, z_{it} > 0\right), \tag{6}$$

where $\overline{w}_{it} = 1/J \sum_{j=1}^{J} w_{ijt}$ and $\overline{x}_{it} = 1/J \sum_{j=1}^{J} x_{ijt}$ (J is the number of outlets for product i).

$$p_{it}^{+} = E\left(z_{it} \middle| \overline{w}_{it}^{ex\_VAT}\right) \text{ and } \mu_{it}^{+} = E\left(y_{it} \middle| \overline{x}_{it}^{ex\_VAT}, z_{it} > 0\right) \tag{7}$$

where $\overline{w}_{it}^{ex\_VAT} = 0$ and $\overline{x}_{it}^{ex\_VAT} = 0$ for columns representing VAT variables, $\overline{w}_{it}^{ex\_VAT} = \overline{w}_{it}$ and $\overline{x}_{it}^{ex\_VAT} = \overline{x}_{it}$ otherwise.

The point forecast was made for three main dates of VAT rate change, i.e. January 2009, January 2011, and July 2012. The effect of VAT change on price adjustment was estimated only for those products that were available in the CPI micro database (except fuel, for which full pass-through was assumed). Unfortunately, micro data were not available for many important products. To a large extent, these were administratively regulated products, thus for corresponding products we could assume 100% pass-through of a VAT rate shock. In addition, we took into account the share of those products, which are not subject to VAT (e.g. secondary and tertiary education, tourism, etc.). After the evaluation of VAT effects on individual product groups, those were aggregated using weights in the consumer basket. The overall results as well as the results by main group and economic category are reported in Table 3.

[21] Forecasts for downward price revisions were made in a similar way using the results from Tables A7 and A8.

Table 3
Estimated effect of changes in VAT rate (percentage points)

	January 2009	January 2011	July 2012
1 Food and non-alcoholic beverages	0.864	0.508	–0.111
2 Alcoholic beverages, tobacco	0.324	0.028	–0.078
3 Clothing and footwear	0.107	0.024	0.017
4 Housing, water, electricity, gas and other fuels	0.625	0.492	–0.052
5 Furnishing, household equipment, etc.	0.136	0.015	0.017
6 Health	0.096	0.075	0.000
7 Transport	0.361	0.120	–0.054
8 Communication	0.161	0.066	0.015
9 Recreation and culture	0.279	0.064	0.020
10 Education	0.002	0.001	0.000
11 Restaurants and hotels	0.127	0.017	0.004
12 Miscellaneous goods and services	0.104	0.038	–0.004
Food	0.864	0.508	–0.111
Energy	0.124	0.080	–0.049
Non-energy goods	1.279	0.316	–0.011
Services	0.242	0.050	0.005
Administratively regulated	0.678	0.493	–0.060
Total	**3.187**	**1.449**	**–0.226**
Pass-through (%)	**83.9**	**113.9**	**36.0**

Sources: CSB and authors' calculations.
Notes: Estimates based on the sample selection models are reported in Tables A5–A8. Full pass-through is assumed for fuel and administratively regulated prices. Although one can calculate confidence bands for p and μ, it was not possible to calculate them for figures in Table 3. The analytical solution is too complex due to non-linearity of equation (2) and non-normal distribution of p, while bootstrap procedure is not feasible even for a relatively small number of iterations.

The overall effect of changes in VAT rate on inflation in Latvia was rather high and fast in both cases of upward VAT revision. The immediate pass-through of January 2009 is evaluated to be 83.9%, increasing inflation by 3.2 percentage points. Although the demand conditions were extremely low at that time, the significant increase of VAT (from 18% to 21% for standard rate) ensured a relatively high pass-through to prices. The role of the weak demand can be seen when making comparison with the VAT pass-through two years later. Despite a much lower increase in VAT rate, the pass-through to prices was more pronounced and the estimated figure even exceeded 100%, contributing 1.4 percentage points to aggregate inflation. Obviously, the demand conditions in 2011 were much more favourable vis-á-vis the beginning of 2009. Moreover, a pass-through of more than 100% may be explained by the lack of demand in 2009–2010 and an incomplete pass-through of VAT increase in 2009, leading to squeezing mark-ups. Possibly, the VAT rate adjustment together with improving consumer demand gave some firms an opportunity to widen mark-ups in early 2011.

The abovementioned observations for cases of upward VAT rate adjustments are in sharp contrast to the case of VAT rate reduction in mid-2012, as the estimated effect

on inflation is low (only –0.2 percentage point). The pass-through was weak (only 36%), clearly showing the asymmetric reaction of Latvian firms.[22]

As regards the contribution of individual product groups/categories, the highest contribution comes from food, to a large extent determined by importance in the consumption basket. In 2009 and 2011, food products determined one third of total contribution. In 2012, however, food products contributed more than a half of total immediate impact. Much of the contribution in 2009 came from non-energy goods (alcoholic beverages and tobacco, clothing and footwear, furnishing, recreation and culture); non-negligible was the contribution of services (mainly restaurants and hotels). In 2011, the role of services was much smaller, and the pass-through was mostly provided by goods. Except food, the inflation reduction in 2012 due to VAT was observed for transport (mainly fuel), alcoholic beverages and tobacco. Finally, the tax reduction in 2012 seems to have produced no significant impact on services. The most probable explanation is the growing domestic demand that allowed firms to postpone price reductions. Although demand is an important factor for all products, we need to take into account that services prices are very rigid and therefore largely depend on expected demand. According to business and consumer survey data of the EC, demand expectations of firms working in the services sector were on the rise in 2012, thus seriously affecting price setting decisions. Another factor explaining low willingness to reduce prices in services was a sizeable inflow of tourists, which especially affected the demand for restaurant and hotel services.

[22] This is in line with the results obtained by Gábriel and Reiff (2010) for Hungary. They report that the inflation effect of 5 percentage point increase in VAT rate in September 2006 is estimated to be 2.13%, while the inflation effect of 5 percentage point decrease in VAT rate in January 2006 is only –1.08% (for affected products).

CONCLUSIONS

The access to consumer price data on the outlet level gives a unique opportunity to evaluate the impact of changes in VAT rate on inflation by analysing the effect on frequency and size of price changes. The case of Latvia is especially interesting for analysis, as during a relatively short period there were three major VAT adjustments (January 2009, January 2011, and July 2012); in addition, the tax was reduced in the latter case.

Useful insights were obtained by looking at frequencies and sizes of price revisions during and after these periods of tax rate adjustments. Although the frequency of price changes in the corresponding months of 2009, 2011 and 2012 was abnormally high, it is still far below 100%: the frequency of price decrease in July 2012 slightly exceeded 25%, while the frequency of price increase reached approximately 45% and 35% respectively in January 2009 and January 2011. These overall figures mask a large degree of heterogeneity across groups, especially in July 2012, when a higher effect on frequency was observed for food products (except fruits and vegetables), while the impact was much lower for services and some other groups of products (e.g. clothing and footwear). In addition, the examination of micro data suggests that in most cases the average size of revisions reacted in the opposite direction, thus compensating for higher frequency of price adjustments at the moment of tax rate change. Another important aspect is the lagged effect of VAT rate change, which, if existing, is rather small and cannot be detected.

To quantify the impact of change in VAT rate on inflation in different periods, the sample selection model was estimated for 13 different product groups. The contribution of VAT rate to positive and negative price revisions was calculated for each sample product and then the aggregated figure was obtained (for fuel and administratively regulated prices assuming a full pass-through of VAT rate changes). The evaluated effect on inflation in Latvia was rather high for the cases of increase in VAT rate. In January 2009, the immediate pass-through was evaluated at 84% level (contributing 3.2 percentage points to overall inflation), while in January 2011, the pass-through to prices exceeded 100% (contributing 1.4 percentage points). Although the change in VAT rate was steeper in the former case, the pass-through was obviously restricted by weak demand conditions. This evidence is in contrast to the immediate effect of VAT rate reduction in mid-2012 when the pass-through to inflation was only 36% (decreasing inflation by 0.2 percentage point). The VAT reduction in 2012 seems to have given no significant impact on prices of services due to high demand expectations, with the main effect on inflation observed in food, transport (mainly fuel), alcoholic beverages and tobacco products.

Overall, the CPI micro data evidence suggests that the pass-through of VAT rate to prices is strong in case of increasing tax rate (especially when there are no restrictions from the demand side), while the effect is much smaller for cases of VAT rate reduction. There is a clear peak in frequencies of price changes in the month of rate adjustment, compensated, however, by smaller average size of price changes. In addition, the pass-through exhibits a high degree of heterogeneity by product group with a higher pass-through for goods (especially food) and lower for services. This knowledge can be used both in historical analysis of inflation and forecasting inflationary effects of indirect tax rate changes in the future.

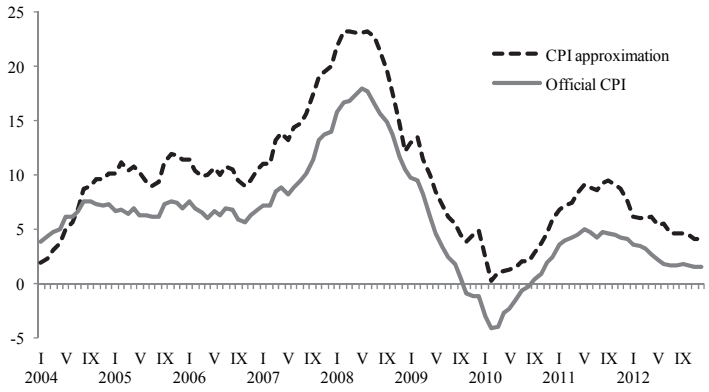
APPENDIX

Table A1
Sample coverage in 2012 for Latvia

	Share in CPI (%)	Share in sample (%)	Coverage (%)
1 Food and non-alcoholic beverages	24.8	15.1	60.9
2 Alcoholic beverages, tobacco	7.2	5.7	79.9
3 Clothing and footwear	5.5	2.4	43.1
4 Housing, water, electricity, gas and other fuels	16.7	2.0	11.9
5 Furnishing, household equipment etc.	4.3	2.0	46.9
6 Health	5.7	1.1	19.3
7 Transport	13.9	6.7	48.1
8 Communication	4.1	0.1	2.0
9 Recreation and culture	7.4	3.0	40.0
10 Education	1.5	0.0	3.2
11 Restaurants and hotels	3.8	1.8	47.6
12 Miscellaneous goods and services	5.3	2.1	40.5
Total	**100.0**	**42.0**	**42.0**

Sources: CSB and authors' calculations.
Notes: Shares in CPI show the shares of particular groups in CPI basket in 2012 (%). The share in the sample denotes the share of products from a particular group presented in our database in the CPI basket in 2012 (%). Coverage indicates the share of products covered by our database within a group in 2012 (%).

Figure A1
Annual changes in CPI and CPI approximation (2004–2012)



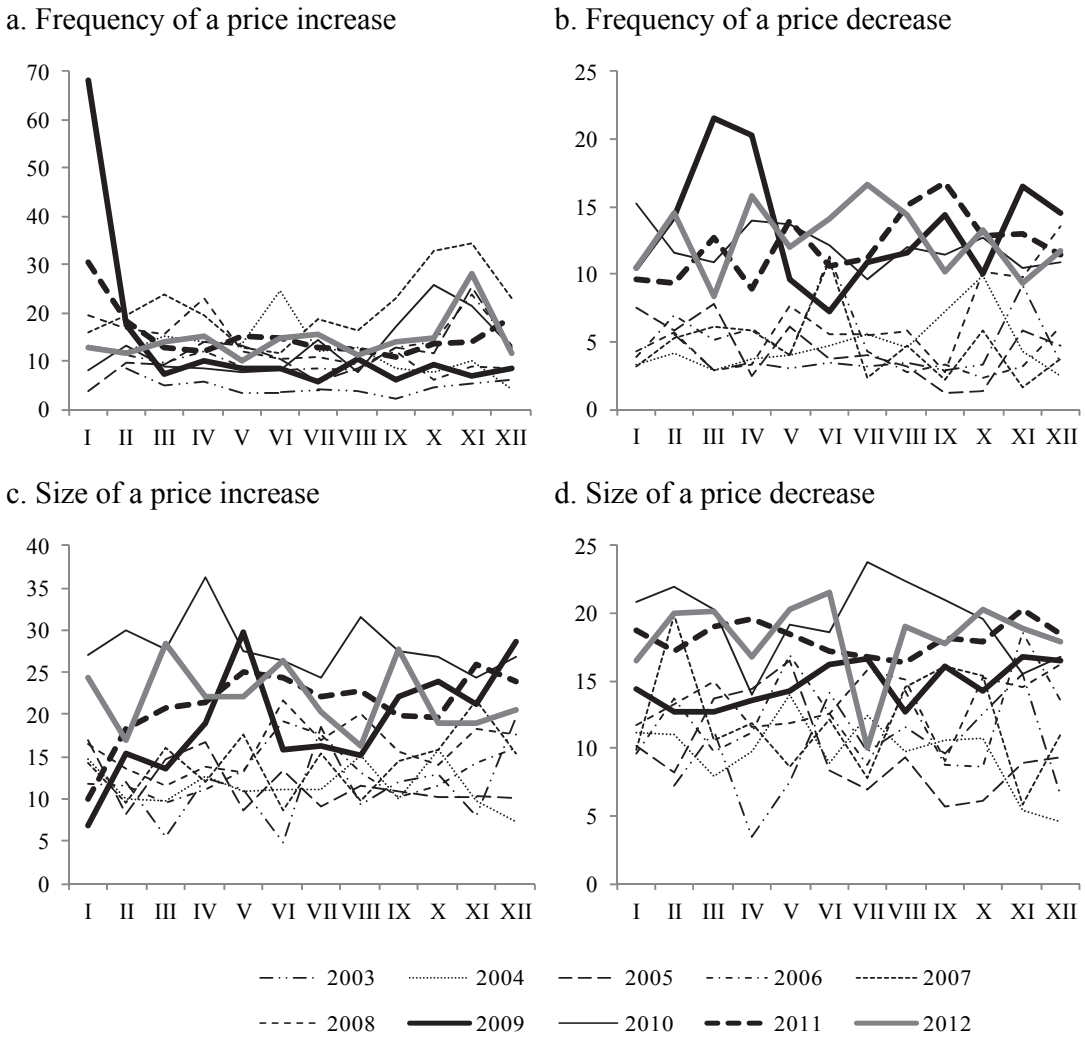
Sources: CSB and authors' calculations.
Note: Annual changes in CPI and CPI approximation are calculated from the CPI micro data (%).

Table A2
Description of product groups

Group	Share in sample (%)	No. of products	No. of product-outlet pairs
Bread and cereals	2.6	10	529
Meat and fish	3.0	12	550
Milk, cheese and eggs	4.0	9	474
Fruits and vegetables	2.1	11	635
Other food products	1.8	11	557
Non-alcoholic beverages	1.5	5	262
Alcohol and tobacco	5.7	6	217
Clothing and footwear products	2.3	26	666
Furnishing and household equipment products	1.9	20	593
Fuel	5.7	3	14
Communication, recreation and culture products	2.5	15	512
Other products	3.8	23	763
Restaurants and hotels	1.7	9	332
Other services	3.4	21	530
Total	**42.0**	**181**	**6634**

Sources: CSB and authors' calculations.
Note: Shares in sample are provided for 2012 (%).

Figure A2
Frequency and size of positive and negative price changes over time for bread and cereals (2003–2012)

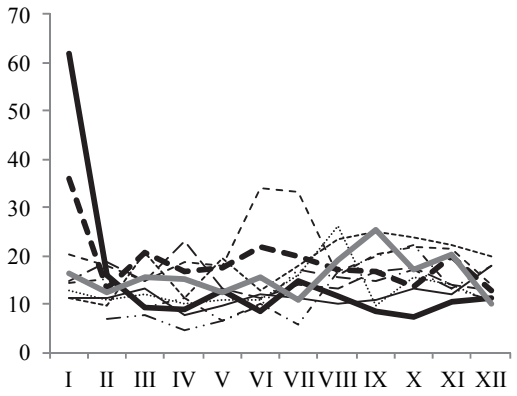


Sources: CSB and authors' calculations.
Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

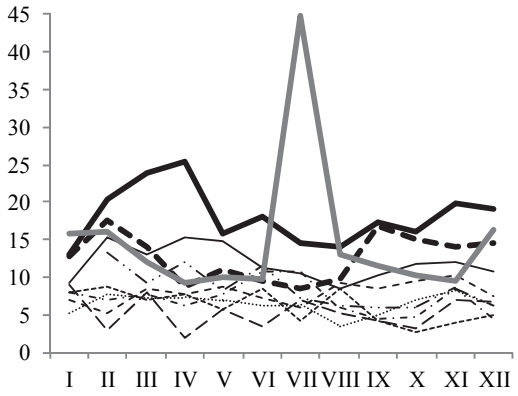
Figure A3

Frequency and size of positive and negative price changes over time for meat and fish (2003–2012)

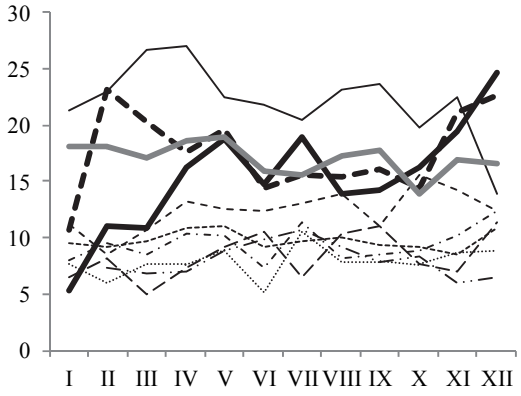
a. Frequency of a price increase



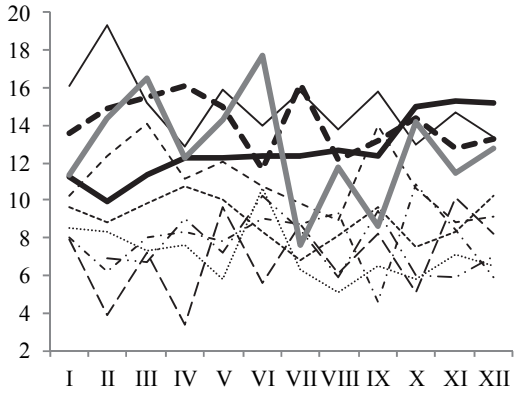
b. Frequency of a price decrease

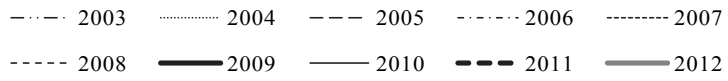


c. Size of a price increase



d. Size of a price decrease





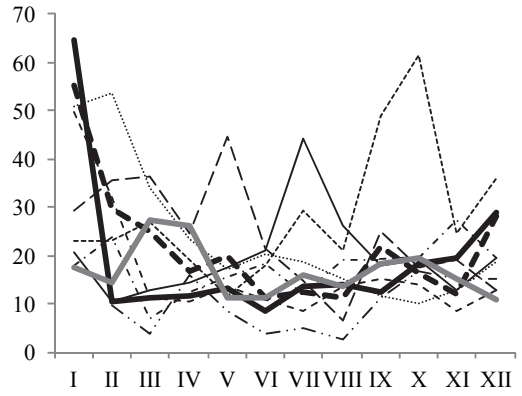
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

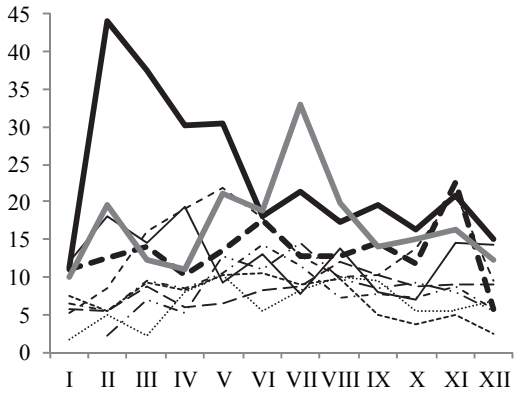
Figure A4

Frequency and size of positive and negative price changes over time for milk, cheese and eggs (2003–2012)

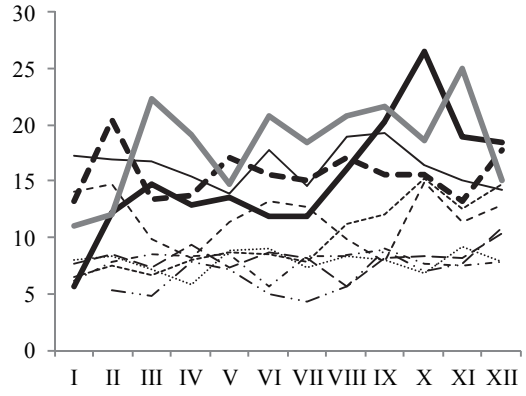
a. Frequency of a price increase



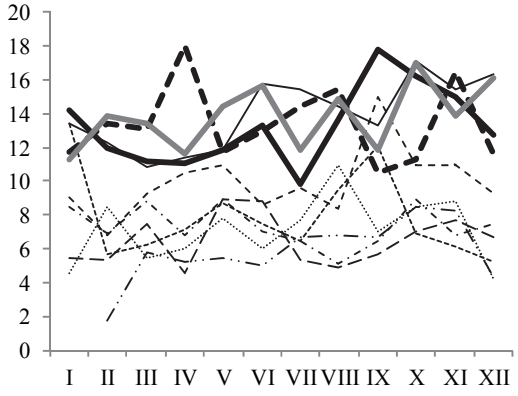
b. Frequency of a price decrease

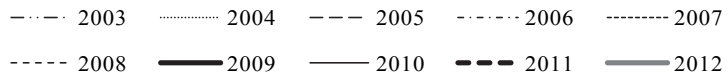


c. Size of a price increase



d. Size of a price decrease



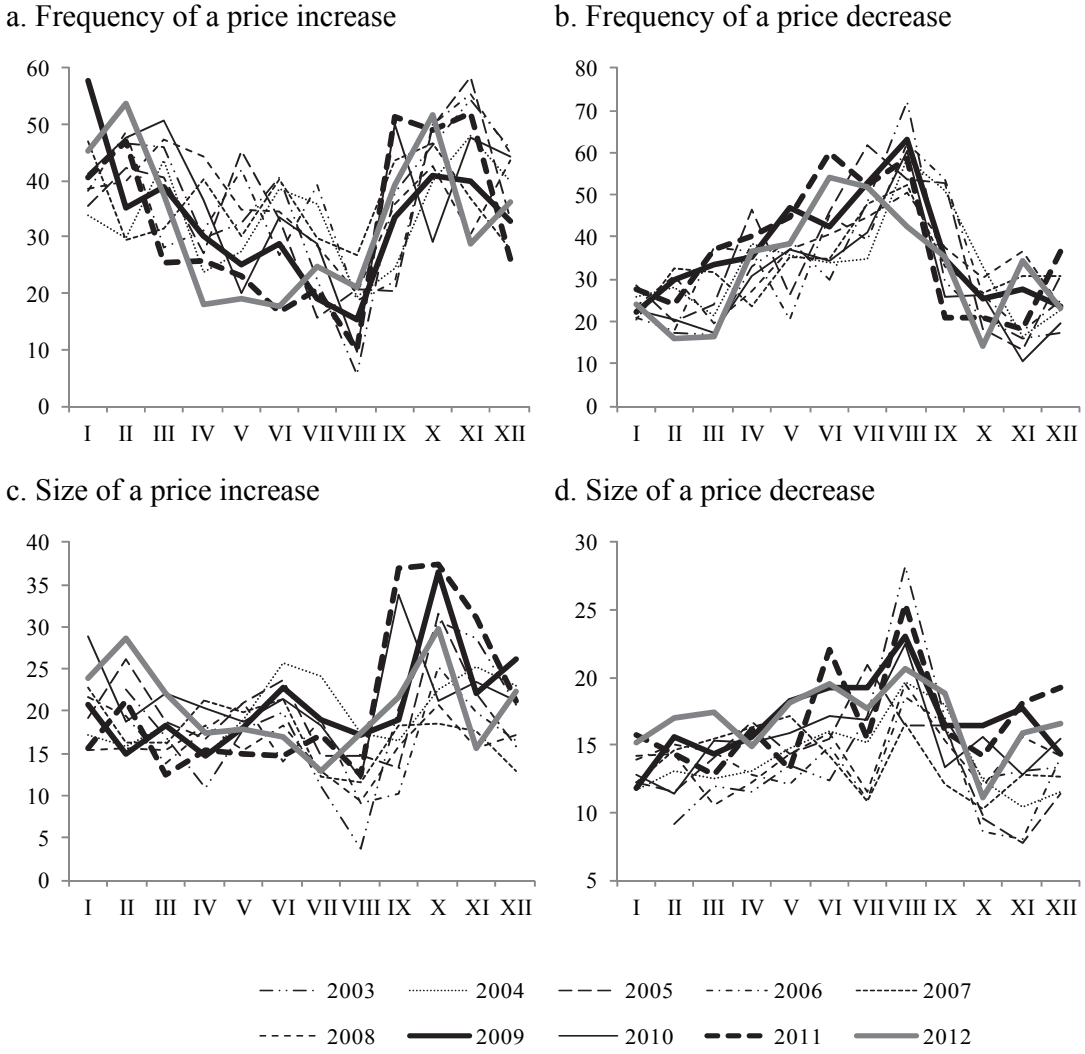


Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

Figure A5

Frequency and size of positive and negative price changes over time for fruits and vegetables (2003–2012)

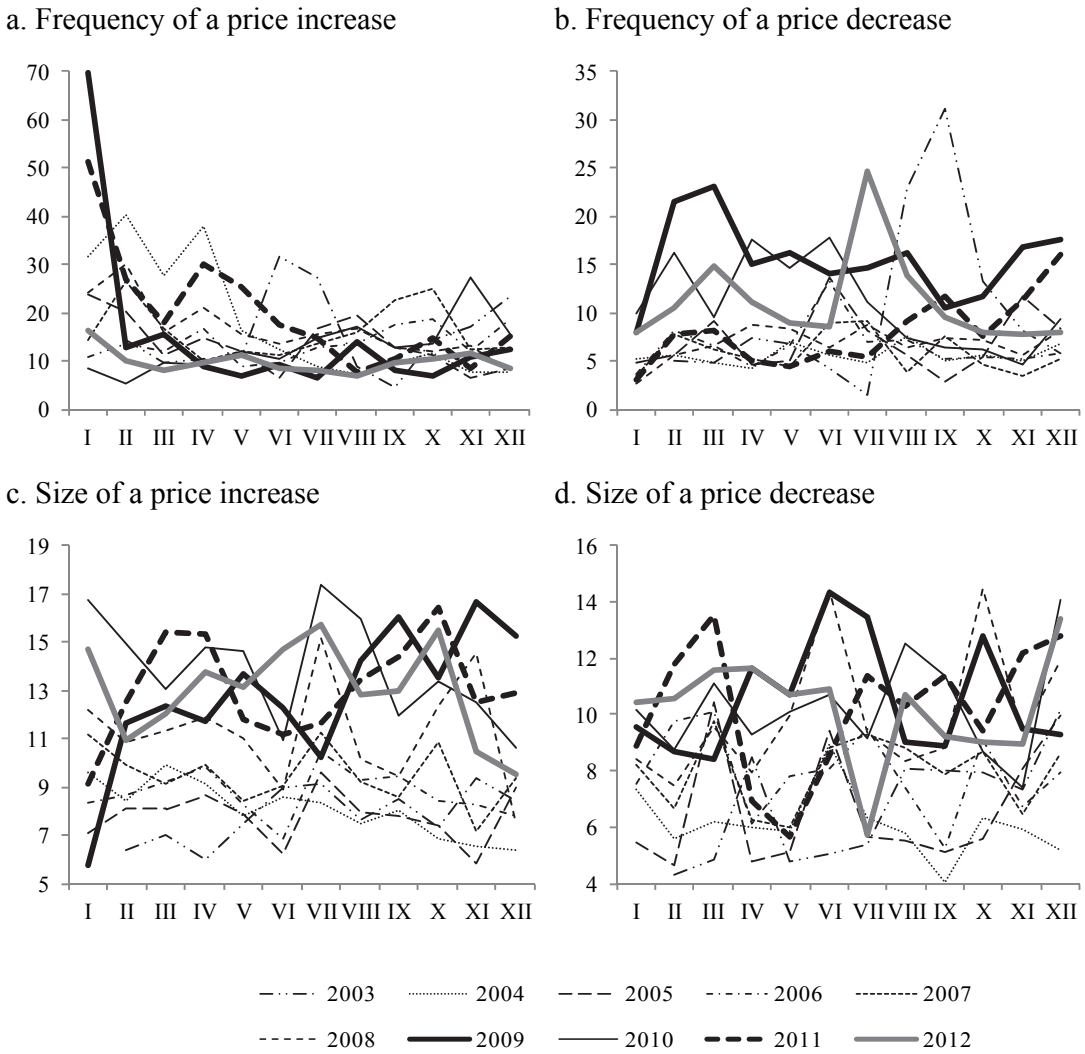


Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

Figure A6

Frequency and size of positive and negative price changes over time for other food products (2003–2012)



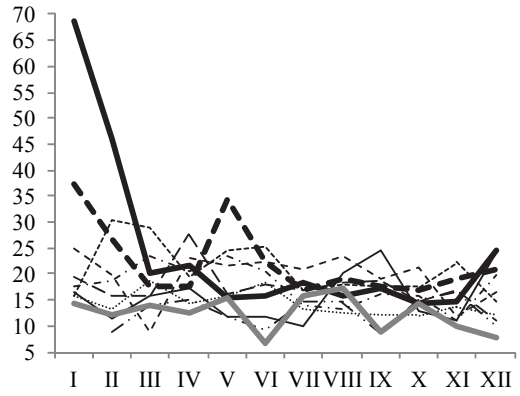
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

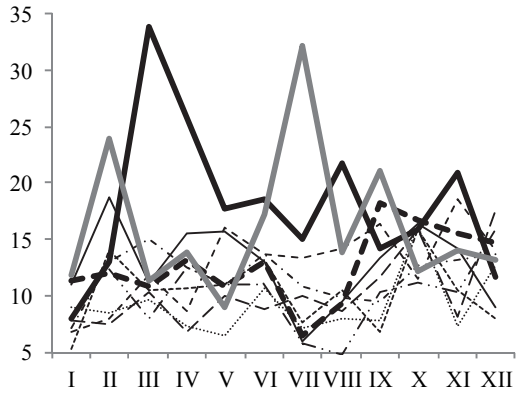
Figure A7

Frequency and size of positive and negative price changes over time for non-alcoholic beverages (2003–2012)

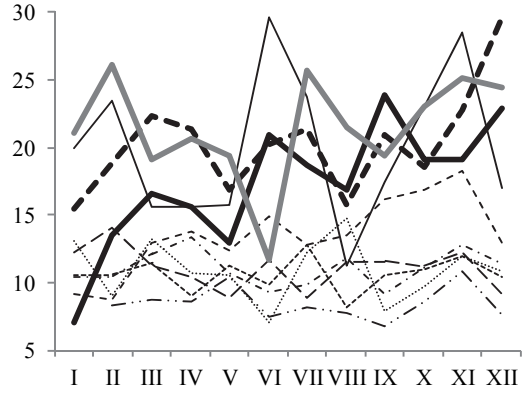
a. Frequency of a price increase



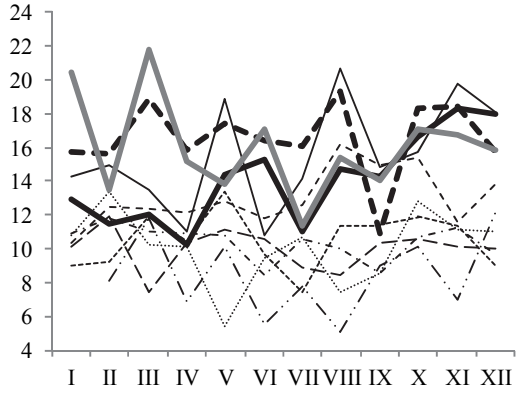
b. Frequency of a price decrease

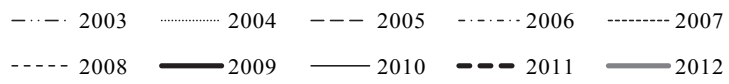


c. Size of a price increase



d. Size of a price decrease





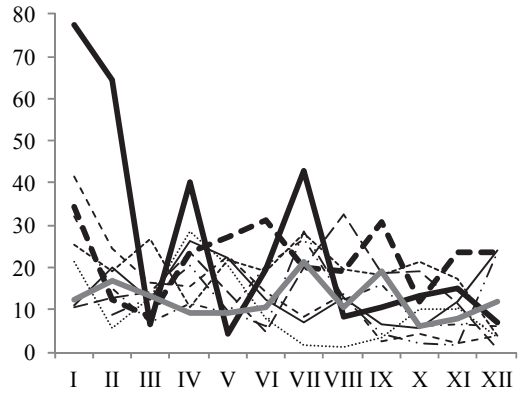
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

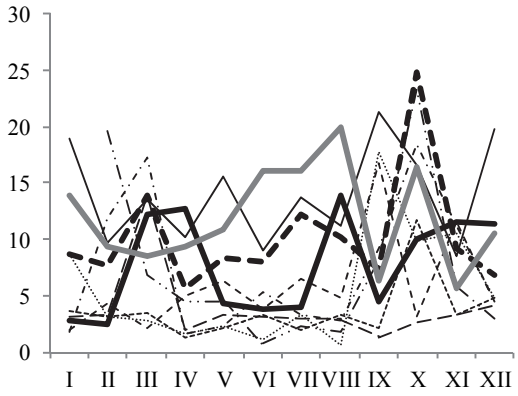
Figure A8

Frequency and size of positive and negative price changes over time for alcohol and tobacco (2003–2012)

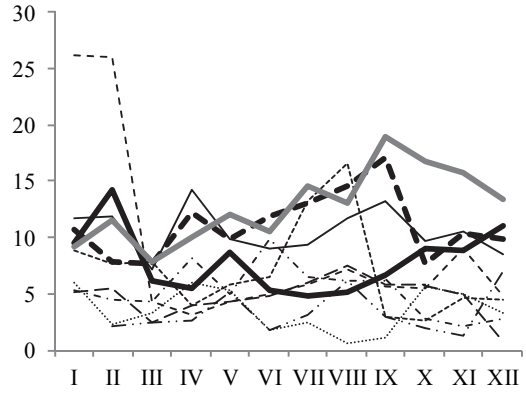
a. Frequency of a price increase



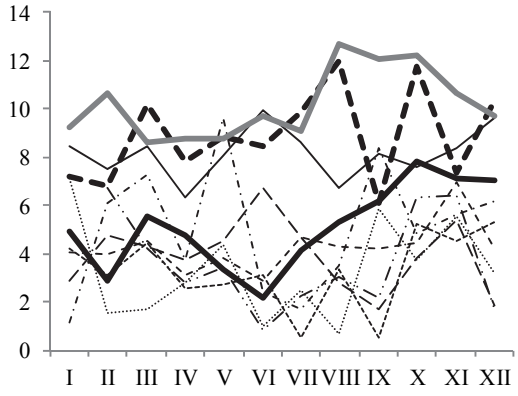
b. Frequency of a price decrease

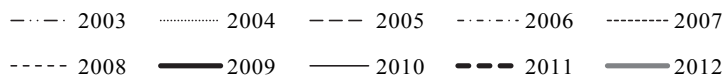


c. Size of a price increase



d. Size of a price decrease





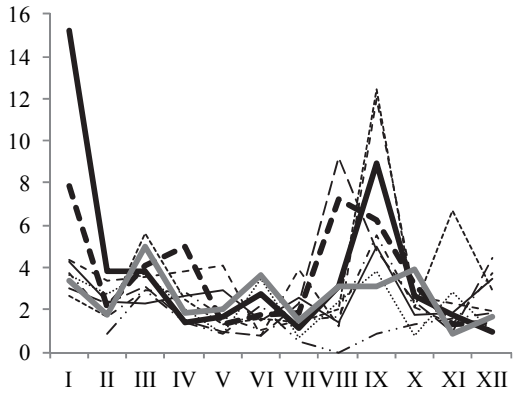
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

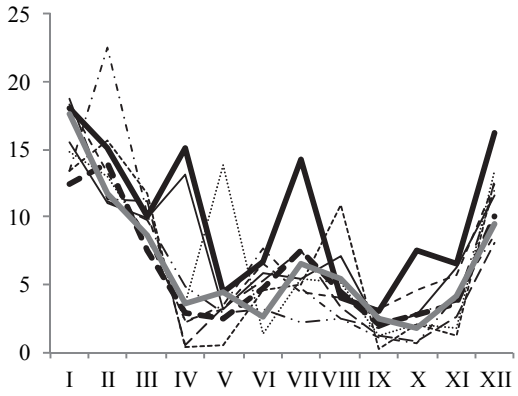
Figure A9

Frequency and size of positive and negative price changes over time for clothing and footwear products (2003–2012)

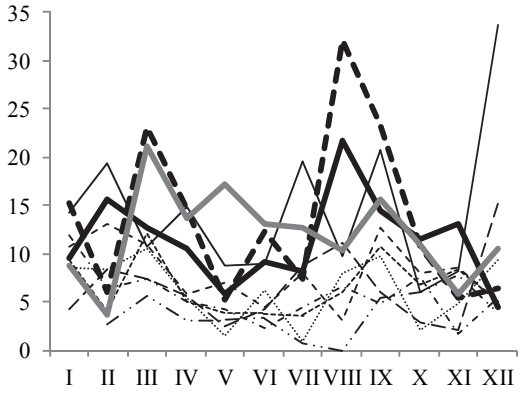
a. Frequency of a price increase



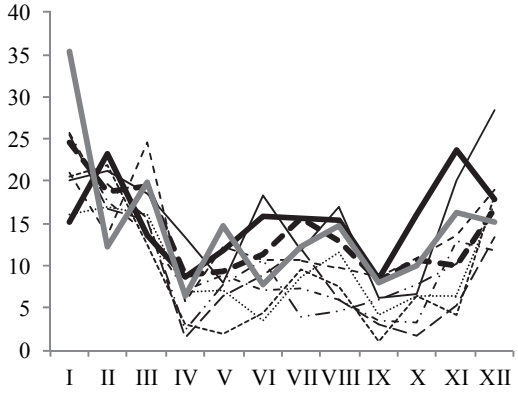
b. Frequency of a price decrease

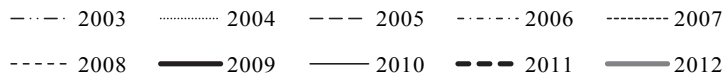


c. Size of a price increase



d. Size of a price decrease





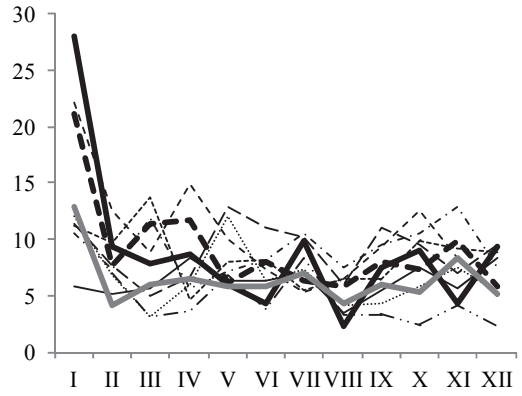
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

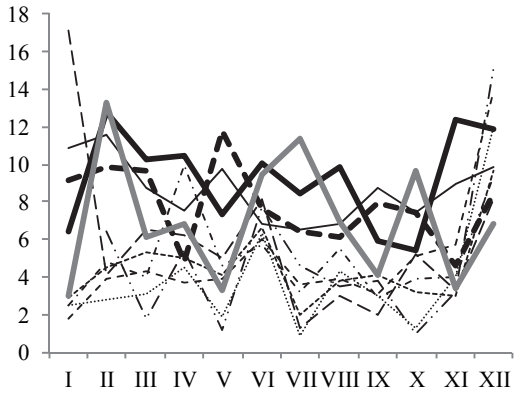
Figure A10

Frequency and size of positive and negative price changes over time for furnishing and household equipment products (2003–2012)

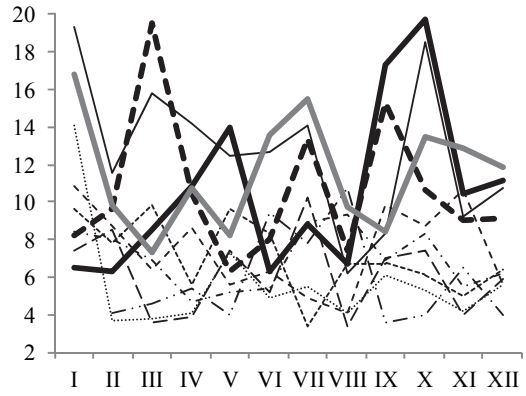
a. Frequency of a price increase



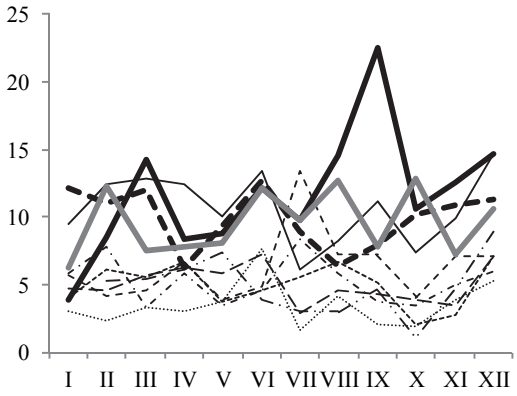
b. Frequency of a price decrease

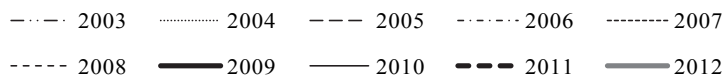


c. Size of a price increase



d. Size of a price decrease



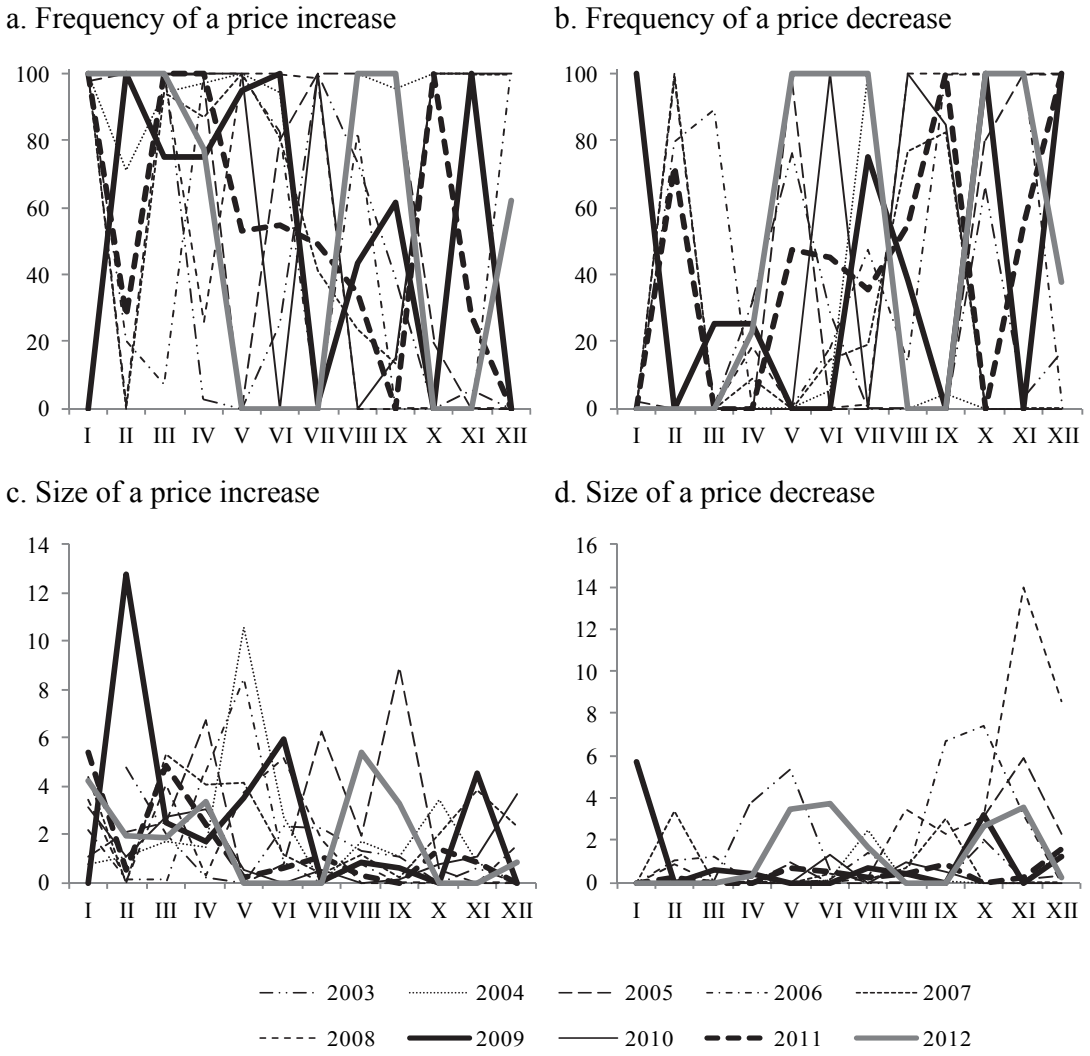


Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

Figure A11

Frequency and size of positive and negative price changes over time for fuel (2003–2012)



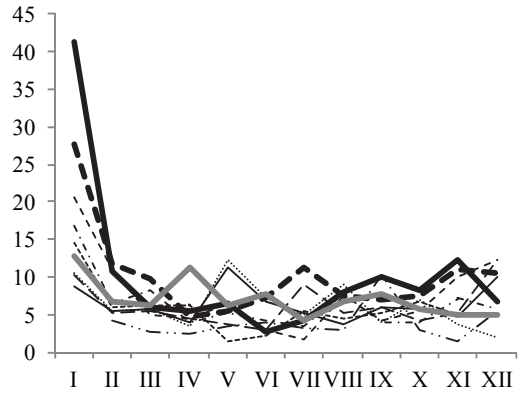
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

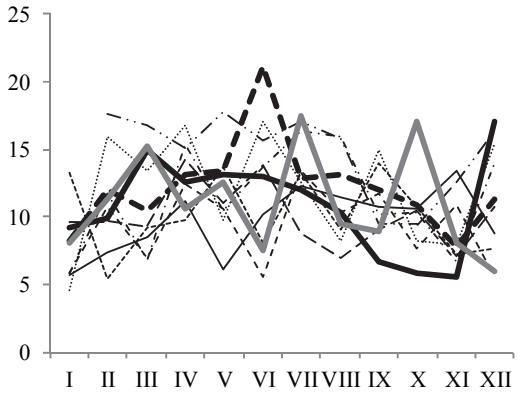
Figure A12

Frequency and size of positive and negative price changes over time for communication, recreation and culture products (2003–2012)

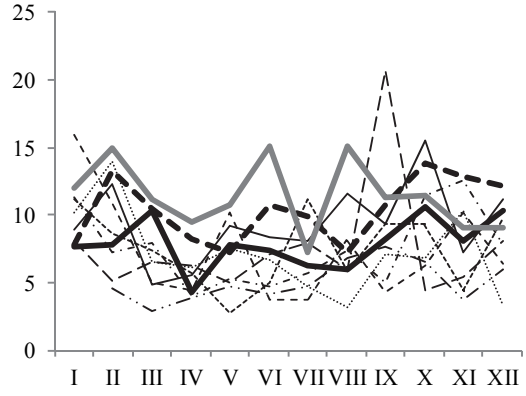
a. Frequency of a price increase



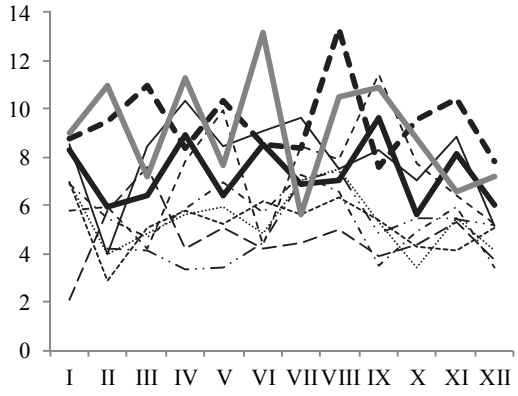
b. Frequency of a price decrease

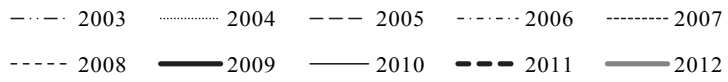


c. Size of a price increase



d. Size of a price decrease





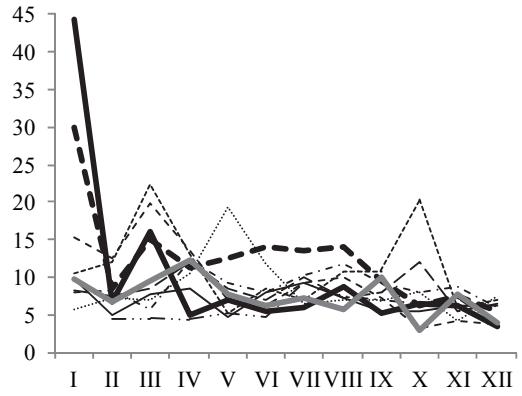
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

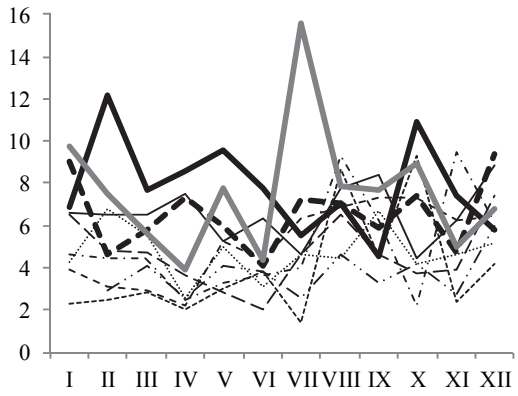
Figure A13

Frequency and size of positive and negative price changes over time for other products (2003–2012)

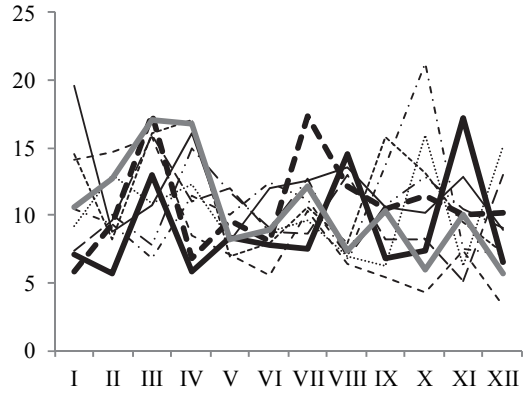
a. Frequency of a price increase



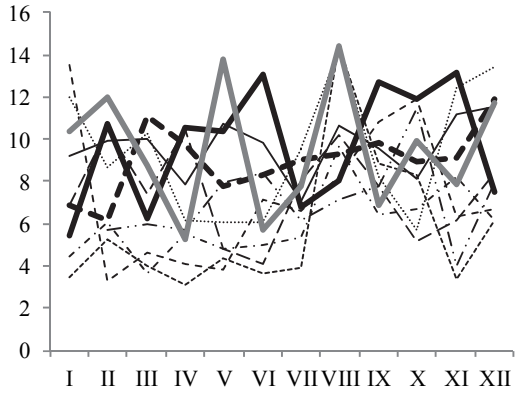
b. Frequency of a price decrease

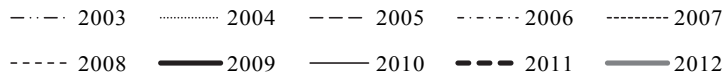


c. Size of a price increase



d. Size of a price decrease





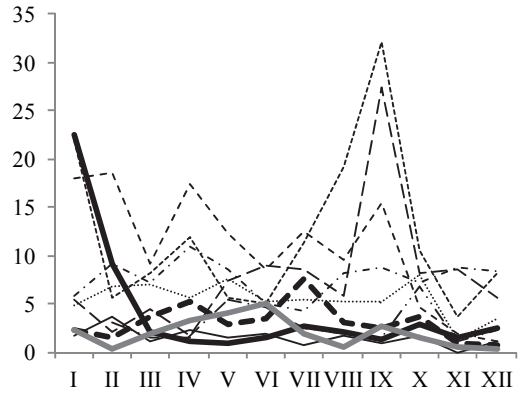
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

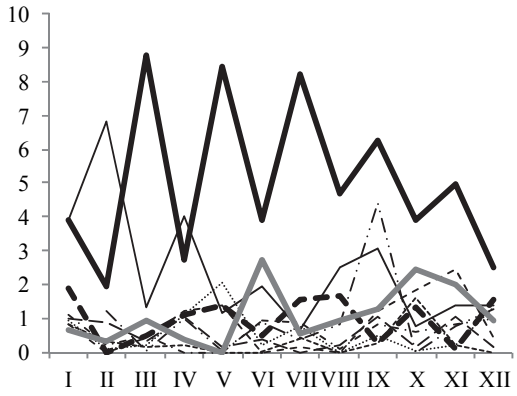
Figure A14

Frequency and size of positive and negative price changes over time for restaurants and hotels (2003–2012)

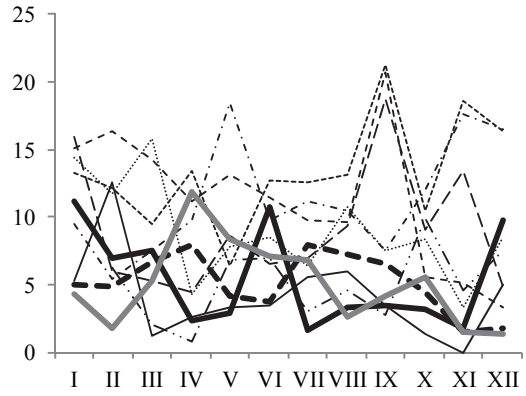
a. Frequency of a price increase



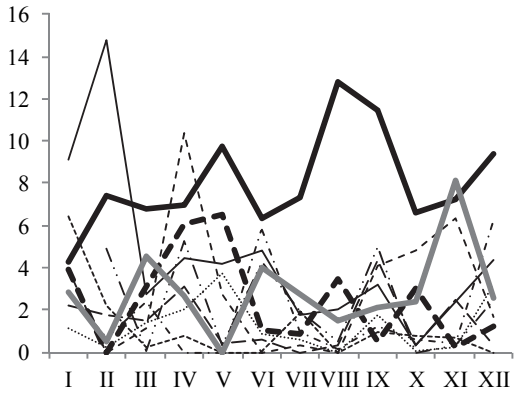
b. Frequency of a price decrease

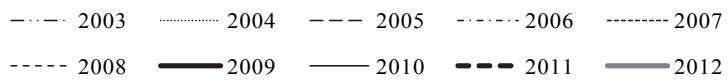


c. Size of a price increase



d. Size of a price decrease





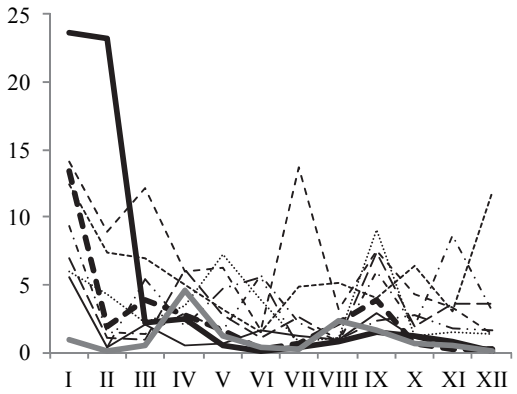
Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

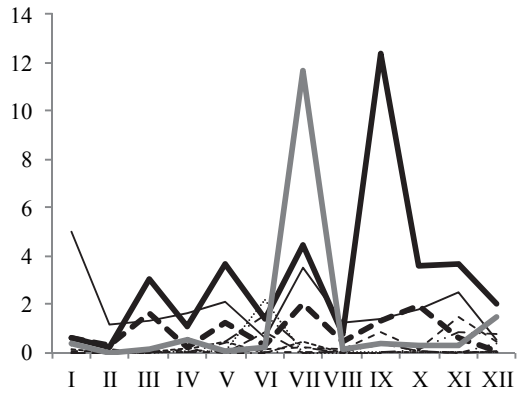
Figure A15

Frequency and size of positive and negative price changes over time for other services (2003–2012)

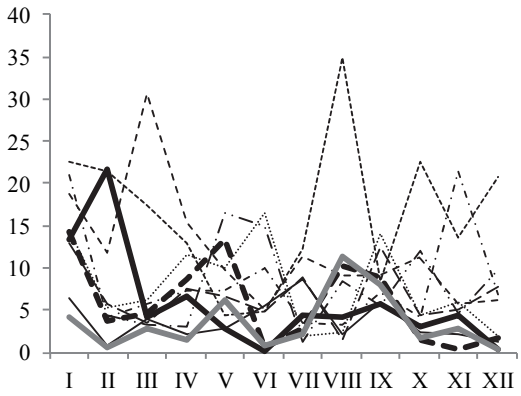
a. Frequency of a price increase



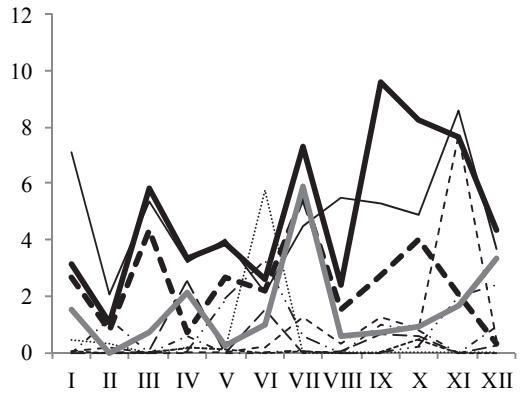
b. Frequency of a price decrease

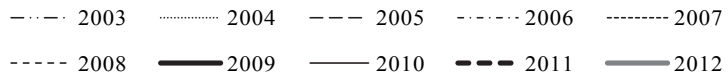


c. Size of a price increase



d. Size of a price decrease





Sources: CSB and authors' calculations.

Notes: Frequency shows the average share of prices that are changed during one month (%); average price changes show the average changes of prices (%).

Table A3

Non-standart VAT rates in Latvia (2003–2012)

COICOP code	Description	2003 01	2004 01	2004 05	2005 01	2006 07	2007 01	2009 01	2009 08	2010 05	2011 01	2011 07	2012 07
Products and services present in the micro-CPI database (with non-standard VAT rate)													
0454	Solid fuels	18	18	18	18	18	5	21	10	10	12	12	12
0612	Medical products*	9	5	5	5	5	5	10	10	10	12	12	12
0621	Medical and paramedical services*	no	no	no	no	no	no	no	no	no	no	no	no
0622	Dental services	no	no	no	no	no	no	no	no	no	no	no	no
0623	Other medical services	no	no	no	no	no	no	no	no	no	no	no	no
0732	Passenger transport by road	18	18	18	5	5	5	10	10	10	12	12	12
0942	Cultural services (cinema)	0	0	5	5	5	5	21	21	21	22	22	21
0942	Other cultural services	no	no	no	no	no	no	no	no	no	no	no	no
0951	Books (educational and original literature)	0	0	5	5	5	5	21	10	10	12	12	12
0952	Newspapers and periodicals	9	9	5	5	5	5	10	10	10	12	12	12
1120	Accommodation services	9	9	5	5	5	5	21	21	10	12	12	12
1211	Hairdressing services	18	18	18	18	18	5	21	21	21	22	22	21
Administratively regulated prices (with non-standard VAT rate)													
0412	Housing rentals	no	no	no	no	no	no	no	no	no	no	no	no
0441	Water	9	9	5	5	5	5	21	21	21	22	22	21
0442	Refuse collection	9	9	5	5	5	5	21	21	21	22	22	21
0443	Sewerage collection	9	9	5	5	5	5	21	21	21	22	22	21
0451	Electricity	18	18	18	18	18	5	10	10	10	22	22	21
0452	Natural gas (households' consumption)	18	18	18	18	18	5	10	10	10	12	22	21
0455	Heat energy	0	0	0	0	5	5	10	10	10	12	12	12
0612	Medical products*	no	no	no	no	no	no	no	no	no	no	no	no
0630	Medical services*	no	no	no	no	no	no	no	no	no	no	no	no
0731	Passenger transport by railway	18	18	18	5	5	5	10	10	10	12	12	12
0732	Passenger transport by road	18	18	18	5	5	5	10	10	10	12	12	12
0810	Postal services	no	no	no	no	no	no	no	no	no	no	no	no
1010	Pre-primary and primary education	no	no	no	no	no	no	no	no	no	no	no	no
1240	Social protection services	no	no	no	no	no	no	no	no	no	no	no	no
1262	Pension payment delivery services	no	no	no	no	no	no	no	no	no	no	no	no
1272	Passport issue services	no	no	no	no	no	no	no	no	no	no	no	no

Source: Law on Value Added Tax, the Republic of Latvia (http://www.likumi.lv/doc.php?id=34443&version_date=01.01.2009).
Note: * according to a list approved by the regulations of the Cabinet of Ministers of the Republic of Latvia.

Table A4

Excise duty for selected products in Latvia (2003–2012)

COICOP code	Description	2003 01	2004 01	2004 05	2005 01	2006 07	2007 01	2009 01	2009 08	2010 05	2011 01	2011 07	2012 07
0121	Coffee, LVL per 100 kg	0	0	50	50	50	50	50	50	100	100	100	100
0122	Soft drinks, LVL per 100 litres	0	0	2	2	2	2	2	2	4	4	4	5.2
0211	Spirits, LVL per 100 litres	25	25	30	30	30	30	30	30	40	40	45	45
0212	Wine, LVL per 100 litres	25	25	30	30	30	30	30	30	40	40	45	45
0213	Beer, LVL per litres	1.2	1.2	1.22	1.22	1.3	1.3	1.3	1.3	1.45	2.18	2.18	2.18
0220	Tobacco (cigarettes), LVL per 1 000 cigarettes	5.8	6.3	6.3	6.9	7.6	10	17.8	22.5	22.5	22.5	22.5	22.5

Source: Law on Excise Duties, the Republic of Latvia (http://www.likumi.lv/doc.php?id=81066&version_date=01.02.2012).

Table A5

Output equation for positive price changes

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
VAT_plus	–21.00***	–11.82***	–6.409**	–10.23***	–11.56***	–5.582	–0.116	–9.536	–8.289	–1.768*	–7.156***	6.012***	–5.545*
VAT_plus^2	455.9***	142.7	15.55	258.1*	209.09***	–43.51	–226.0	114.7	86.97	17.02**	42.11***	–30.55***	30.92*
VAT_minus	6.123**	–1.846	–0.564	4.926*	–3.907	–2.261	4.174	–71.23***	–5.838	0.069	–1.977	–3.502***	–0.278
π_total	–0.368	0.130	0.304*	–3.374***	–0.130	0.154	–0.758	0.693	0.367	1.171***	0.030	0.104	1.660
π_group	0.149	–0.184	–0.184	2.710***	0.132	–0.047	0.675**	–0.540	–0.105	–0.514**	–0.053	0.184	–0.582
*Year*2004	–0.002	0.007	0.006	0.010	0.018***	0.016*	0.015	–0.032	–0.047*	0.001	–0.023	0.004	–0.053
*Year*2005	–0.018	0.005	0.003	0.015	0.015**	0.007	–0.028	–0.033	–0.057**	0.027	–0.013	0.015	–0.112**
*Year*2006	0.004	0.015**	0.000	–0.008	0.021***	0.016*	0.009	–0.051	–0.055**	0.065***	–0.001	0.023	–0.080*
*Year*2007	–0.011	0.016**	0.008	–0.017	0.037***	–0.004	0.012	–0.056	–0.040	0.032*	–0.027*	0.063**	–0.071
*Year*2008	0.029**	0.021***	0.051***	–0.029***	0.063***	0.022***	0.048*	–0.060	–0.050*	0.030*	–0.028*	0.036	–0.109**
*Year*2009	0.041***	0.105***	0.089***	0.035***	0.086***	0.057***	0.019	0.010	0.038	0.023	0.022	–0.054**	0.063
*Year*2010	0.091***	0.133***	0.085***	0.010	0.088***	0.091***	0.029	0.054	0.091***	0.062***	0.046***	–0.119***	–0.027
*Year*2011	0.040***	0.073***	0.077***	–0.020	0.059***	0.079***	0.011	0.045	0.013	0.046***	–0.021	–0.069**	0.005
*Year*2012	0.040***	0.063***	0.102***	0.024**	0.090***	0.110***	0.088***	0.018	0.011	0.097***	0.021	–0.097***	0.034
January	–0.021*	–0.021**	–0.024***	0.007	–0.015**	0.005	–0.010	–0.149***	–0.016	–0.041***	–0.044**	0.068***	–0.100
February	–0.055***	–0.023**	–0.019***	0.013	–0.024***	0.000	0.065*	0.014	–0.008	0.035*	–0.044**	0.042**	–0.018
March	–0.042***	–0.019*	–0.019***	0.017**	–0.007	–0.001	–0.019	–0.069	0.012	0.006	–0.020	0.015	–0.103
April	–0.042***	–0.009	–0.013	0.021**	–0.012*	–0.011	–0.027	–0.097*	–0.020	0.003	–0.040**	0.065***	–0.123
May	–0.013	–0.007	–0.015**	0.050***	–0.002	–0.011	–0.007	–0.125**	–0.004	–0.010	–0.051***	0.043**	–0.034
June	–0.013	–0.028***	0.002	0.056***	–0.002	0.007	–0.009	–0.090	–0.003	0.018	–0.053***	0.047**	–0.139
July	0.019	–0.016*	–0.012*	0.049***	–0.006	0.010	0.035	–0.051	0.017	0.012	–0.050**	0.057***	–0.075
August	–0.007	–0.037***	0.009	0.042***	–0.005	–0.017*	0.048*	–0.014	0.012	–0.012	–0.063***	0.075***	0.062
September	–0.021*	–0.043***	–0.010	0.104***	0.005	0.009	0.029	–0.143**	0.006	–0.014	–0.037**	0.066***	–0.087
October	–0.024**	–0.040***	0.007	0.147***	0.005	0.011	0.023	–0.113*	0.050*	0.019	–0.001	0.048**	–0.129
November	–0.029***	–0.017*	0.013	0.032***	0.007	0.019*	0.013	–0.047	0.018	–0.022	–0.023	–0.006	–0.080
constant	0.347***	0.268***	0.200***	0.249***	0.184***	0.243***	0.223***	0.768***	0.326***	0.233***	0.379***	–0.323***	0.332
atanh(ρ)	–0.868***	–1.026***	–0.937***	–0.270***	–0.966***	–1.032***	–1.094***	–0.943***	–1.013***	–0.732***	–0.864***	12.97***	–0.162
ln(σ)	–1.789***	–1.883***	–2.101***	–1.318***	–2.184***	–1.933***	–1.987***	–1.166***	–1.856***	–1.926***	–1.785***	–1.635***	–1.735***
ρ	–0.700	–0.772	–0.734	–0.264	–0.747	–0.775	–0.798	–0.736	–0.767	–0.624	–0.698	1.000	–0.161
σ	0.167	0.152	0.122	0.268	0.113	0.145	0.137	0.312	0.156	0.146	0.168	0.195	0.176
$\rho\sigma$	–0.117	–0.118	–0.090	–0.071	–0.084	–0.112	–0.109	–0.229	–0.120	–0.091	–0.117	0.195	–0.028
No. of obs.	42032	39848	30287	42859	53544	23167	19841	20775	24311	24861	49119	22318	40500
Censored obs.	36309	33140	24104	29732	46454	18964	16467	19458	22140	22729	42886	21039	38879
Uncensored obs.	5723	6708	6183	13127	7090	4203	3374	1317	2171	2132	6233	1279	1621

Sources: CSB and authors' calculations.

Notes: *, ** and *** denote significance at 10%, 5% and 1% level respectively. Estimates of equation (5) are obtained by maximum likelihood using product weights in CPI basket. Coefficients before excise dummy variables for non-alcoholic beverages and alcohol and tobacco groups are not reported due to space constraint.

Table A6

Selection equation for positive price changes

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
VAT_plus	98.28***	115.6***	96.14***	35.86*	105.97***	107.6***	–4.000	41.20	48.51	41.11***	57.32***	33.28***	44.86***
VAT_plus^2	–667.4	–1365.6*	–2053.9***	–211.3	–1328.3**	–1753.8	2567. 4	–675.4	–349.7	–69.21	–353.3***	–183.6***	–271.0***
VAT_minus	–25.47*	32.12*	–0.129	–19.58	–0.166	–29.29*	1.214	54.85	–22.51	–7.777	9.685***	–14.87***	–1.552
π_nt_total	9.079***	9.220***	3.005**	–0.844	–0.128	3.607**	19.523***	2.485	5.368***	0.275	4.766***	–0.614	7.608***
π_nt_group	2.445***	–1.576**	10.502***	6.872***	2.456***	0.627	–4.947**	0.618	–0.237	2.317**	–0.082	1.424	–2.556*
Trade	–0.423***	0.025	–0.745***	–0.756***	0.642***	0.034	–0.702	0.273	0.073	0.078	0.056	0.206***	–0.352**
ln(T)	–0.569***	–0.412***	–0.665***	–0.377***	–0.328***	–0.536***	–0.232	–0.226***	–0.496***	–0.319***	–0.211***	0.005	–0.002
Dur1	–0.300***	–0.159	–0.483***	0.462***	–0.110	–0.461***	–0.218	0.126	–0.256	0.069	–0.011	0.014	–0.011
Dur2	–0.422***	–0.185***	–0.393***	0.329***	–0.123*	–0.357***	–0.182	0.026	–0.226**	–0.071	–0.157**	0.016	–0.126
Dur3	–0.261***	–0.127**	–0.143**	0.159*	–0.083*	–0.191***	–0.231	0.114	–0.174*	–0.036	–0.194***	–0.007	0.073
Dur4	–0.155***	–0.070	–0.070	–0.050	–0.084*	–0.093	–0.080	0.125	–0.110	0.034	–0.111	–0.022	–0.136
Dur6	–0.048	–0.013	0.050	–0.022	–0.028	–0.015	0.072	–0.130	0.030	–0.020	0.005	–0.004	–0.023
Dur9	–0.035	0.134**	0.042	–0.176*	0.058	0.136	–0.115	–0.061	0.151	–0.265***	0.056	0.033***	–0.071
Dur12	0.146	–0.039	0.190*	0.053	0.142*	–0.111	0.432**	0.036	–0.069	0.576***	0.205**	0.085***	0.231***
ATP	0.042**	–0.033**	0.073***	–0.035**	0.058***	–0.019	–0.160***	–0.104**	0.062*	–0.057	0.010	–0.058***	–0.141
ATP00	–0.156	–0.133**	0.030	–0.152*	–0.134**	–0.144	–0.010	–0.227***	–0.100	–0.299***	–0.103**	–0.031**	0.027
ATP50	–0.122	–0.085	–0.056	–0.067	–0.080	0.016	0.173	–0.170**	0.087	–0.074	–0.108**	–0.082***	0.087
ATP95	0.109	–0.162**	0.065	–0.052	0.084	–0.359***	–0.188	–0.146	–0.455***	–0.156	–0.149	0.102***	–0.477**
ATP99	–0.066	0.138***	0.158	–0.101	0.138***	–0.110	–0.015	0.012	–0.154**	–0.456***	0.236***	0.072*	–0.486***
LDP	–2.301***	–3.267***	–2.928***	–0.064	–2.881***	–2.813***	–3.060***	–1.105***	–2.502***	–1.671***	–1.960***	–0.249***	–0.603***
*LDP*DW*	0.227***	0.047	0.190***	0.110***	0.111***	0.238***	0.408***	0.050	0.109	0.190***	0.230***	–0.061***	0.100
P_last	–0.061***	–0.012	–0.029***	–0.329***	–0.025***	0.006	–0.054***	–0.002*	–0.001***	0.000	–0.004***	0.003***	0.002
Year2004	0.304***	–0.056	0.276***	–0.140***	0.078	0.029	0.035	0.011	0.323***	0.073	0.139**	0.103	0.103
Year2005	0.220***	0.110**	0.336***	–0.074**	–0.176***	0.220***	0.377**	–0.039	0.492***	–0.095	0.158**	0.100	0.111
Year2006	0.286***	0.026	0.113*	0.030	–0.197***	0.188***	0.399**	0.009	0.527***	0.072	0.104	0.140	0.176
Year2007	0.526***	0.118**	0.235***	–0.180***	–0.048	0.303***	0.547***	–0.008	0.352***	–0.060	0.299***	0.335***	0.332**
Year2008	0.282***	0.266***	–0.124*	–0.061	0.118**	0.238***	0.476***	0.046	0.499***	0.049	0.166**	0.289**	0.240
Year2009	0.154**	–0.230***	–0.035	–0.095**	–0.281***	0.177***	0.858***	0.127	0.377***	0.031	0.050	–0.190	0.130
Year2010	0.358***	–0.058	0.281***	0.085**	–0.132**	0.180***	0.570***	0.160	0.330***	–0.046	0.095	–0.508***	–0.144
Year2011	0.372***	0.208***	0.310***	–0.086**	0.122**	0.509***	0.791***	0.103	0.540***	0.195**	0.335***	–0.297*	0.010
Year2012	0.400***	0.125**	0.177***	–0.002	–0.318***	–0.144**	0.360**	0.094	0.317***	0.003	0.109	–0.432***	–0.262
January	–0.021	–0.112**	0.248***	–0.009	0.206***	0.025	0.321***	0.194	0.241***	0.269***	0.285***	0.384***	0.751***
February	–0.009	–0.062	0.159***	0.170***	0.239***	0.120**	0.360**	–0.343***	–0.005	–0.193**	0.167**	0.239**	0.568***
March	–0.059	–0.122**	–0.025	0.251***	0.000	0.017	0.044	0.066	–0.109	–0.205**	0.390***	0.077	0.282**

Table A6 (cont.)

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
April	0.004	–0.165***	–0.146***	0.039	0.167***	0.048	0.283**	–0.003	0.083	–0.446***	0.196**	0.345***	0.257**
May	–0.157***	–0.169***	–0.189***	0.020	–0.015	0.109*	0.163	0.081	0.034	–0.296***	0.167**	0.220**	0.068
June	–0.121**	–0.055	–0.330***	0.065*	–0.078	0.007	0.150	0.075	–0.012	–0.479***	0.156**	0.228**	–0.081
July	–0.161***	0.075	–0.188***	–0.213***	0.024	–0.047	0.478***	0.036	0.005	–0.302***	0.287***	0.304***	0.223**
August	–0.063	0.125**	–0.116**	–0.472***	0.024	0.135**	0.267*	0.172	–0.100	–0.203**	0.309***	0.389***	–0.081
September	–0.028	0.099*	0.221***	–0.014	–0.070	0.050	0.051	0.438***	0.049	–0.148*	0.186***	0.362***	0.301***
October	0.125**	0.104**	0.088*	0.236***	0.012	–0.041	–0.094	0.124	0.119	–0.215**	0.198***	0.283***	0.047
November	0.325***	0.070	–0.097**	0.187***	–0.008	–0.089*	–0.079	0.035	0.092	–0.048	–0.005	–0.098	0.038
constant	–0.720***	–0.552***	–0.324**	–0.486***	–0.587***	–0.480***	–1.277***	–1.474***	–1.090***	–0.848***	–1.327***	–1.758***	–2.156***

Sources: CSB and authors' calculations.

Notes: *, ** and *** denote significance at 10%, 5% and 1% level respectively. Estimates of equation (5) are obtained by maximum likelihood using product weights in CPI basket. Coefficients before excise dummy variables for non-alcoholic beverages and alcohol and tobacco groups are not reported due to space constraint.

Table A7

Output equation for negative price changes

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
VAT_plus	–5.376	–10.84*	5.823	4.623	–0.752	8.462**	–1.051	–7.626	0.027	–0.475	6.617*	4.382***	8.457
VAT_plus^2	154.4	395.8*	–271.5*	–193.9	8.218	–358.9**	62.35	396.0	186.3	–8.260	–169.8	–33.68***	–55.33
VAT_minus	–12.01***	–16.89***	–5.829***	–3.944**	–10.85***	–12.81***	–6.762	1.030	–10.31*	–3.757**	–0.284	0.152	–2.200
π_total	–0.133	–0.954***	0.054	–0.868***	–0.418**	–0.555**	0.001	0.734	–0.899**	0.655**	0.358	–0.580	–1.055
π_group	–0.106	0.192	–0.379***	0.621***	0.017	0.009	0.018	–0.531	0.264	–0.158	–0.374*	0.124	0.895*
Year2004	–0.003	–0.013*	–0.032***	0.017***	–0.002	–0.011	0.008	0.040	0.030	0.001	0.007	0.022	0.080
Year2005	–0.021*	–0.039***	–0.017**	0.020***	–0.003	0.000	–0.015	–0.013	0.012	0.019**	0.030*	–0.018	–0.019
Year2006	–0.040***	–0.026***	–0.017**	0.038***	–0.007	0.002	–0.005	0.040	0.020	0.011	0.026*	–0.079*	0.065
Year2007	–0.039***	–0.036***	–0.030***	0.022***	–0.006	–0.001	0.000	0.033	–0.004	0.003	0.010	–0.087***	0.136*
Year2008	–0.043***	–0.053***	–0.037***	0.028***	–0.041***	–0.024***	–0.010	0.049*	0.027	0.000	–0.007	–0.056**	–0.021
Year2009	0.004	–0.033***	–0.053***	–0.005	–0.027***	–0.038***	–0.013	0.040	–0.037*	0.024**	0.023	–0.059***	–0.210***
Year2010	–0.054***	–0.095***	–0.081***	0.010	–0.030***	–0.052***	–0.003	0.031	–0.042*	–0.004	0.007	–0.024	–0.201***
Year2011	–0.043***	–0.068***	–0.078***	0.003	–0.055***	–0.063***	–0.042**	0.019	–0.017	–0.014	0.006	–0.052**	–0.141**
Year2012	–0.045***	–0.067***	–0.069***	0.004	–0.049***	–0.049***	–0.060***	0.022	–0.022	–0.003	0.024	–0.041	–0.126*
January	0.012	0.006	0.007	0.009	–0.001	–0.008	0.013	–0.009	–0.034*	0.002	–0.039**	–0.028	–0.013
February	0.012	0.010	0.032***	–0.011	0.025***	0.015	0.009	–0.005	0.024*	–0.008	–0.017	–0.050*	0.076
March	0.007	0.010	0.031***	–0.006	0.013*	0.016*	0.026	–0.030	–0.003	–0.023**	–0.006	0.012	–0.018
April	0.013	0.011	0.027***	0.022***	0.022***	0.019**	0.010	–0.015	0.015	–0.036***	–0.042***	–0.027	0.039
May	–0.012	0.006	0.027***	0.002	0.033***	0.006	–0.003	–0.008	–0.016	–0.037***	–0.036***	–0.005	0.018
June	–0.001	0.004	0.022***	–0.009	0.016**	0.013	–0.008	–0.047**	–0.001	–0.027***	–0.019*	–0.018	0.077*
July	–0.012	–0.001	0.028***	–0.013**	0.018**	0.002	0.025	–0.015	–0.027	–0.042***	0.001	0.004	–0.109**
August	–0.013	0.004	0.006	–0.050***	0.020***	–0.006	0.017	–0.007	–0.033**	–0.018*	–0.048***	–0.016	0.069
September	–0.011	–0.009	–0.002	–0.006	0.019**	0.015	0.028	–0.047	–0.051*	–0.026**	–0.028**	–0.003	–0.056
October	–0.005	–0.002	–0.012	0.009	0.009	–0.005	0.051**	–0.047*	–0.025	–0.023**	–0.036***	–0.024	–0.035
November	–0.011	0.003	0.006	–0.016**	0.024***	–0.003	0.013	–0.009	–0.029*	–0.015	–0.050***	0.010	–0.071
constant	–0.303***	–0.220***	–0.173***	–0.238***	–0.151***	–0.184***	–0.232***	–0.355***	–0.233***	0.051***	–0.328***	–0.085	0.580***
atanh(ρ)	1.050***	0.978***	0.745***	0.482***	0.460***	0.585***	0.857***	0.551***	0.726***	–1.418***	1.122***	0.192	–3.501***
ln(σ)	–2.032***	–2.101***	–2.348***	–2.052***	–2.508***	–2.322***	–2.249***	–1.929***	–2.175***	–2.298***	–1.999***	–2.467***	–1.478***
ρ	0.782	0.752	0.632	0.448	0.430	0.526	0.695	0.501	0.620	–0.889	0.808	0.190	–0.998
σ	0.131	0.122	0.096	0.128	0.081	0.098	0.105	0.145	0.114	0.100	0.135	0.085	0.228
ρσ	0.102	0.092	0.060	0.058	0.035	0.052	0.073	0.073	0.070	–0.089	0.109	0.016	–0.228
No. of obs.	42032	39848	30287	42859	53544	23167	19841	20775	24311	24861	49119	22318	40500
Censored obs.	38572	35767	26742	31557	49449	20345	17715	19269	22935	22997	44955	21900	40132
Uncensored obs.	3460	4081	3545	11302	4095	2822	2126	1506	1376	1864	4164	418	368

Sources: CSB and authors' calculations.

Notes: *, ** and *** denote significance at 10%, 5% and 1% level respectively. Estimates of equation (5) are obtained by maximum likelihood using product weights in CPI basket. Coefficients before excise dummy variables for non-alcoholic beverages and alcohol and tobacco groups are not reported due to space constraint.

Table A8

Output equation for negative price changes

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
VAT_plus	–30.26	3.548	6.896	–3.133	–67.34***	53.85*	–3.145	–5.646	27.07	2.821	14.78	–10.19	–67.10***
VAT_plus^2	864.0	–647.8	–773.1	–127.9	2488.4**	–2697. 3**	–236.6	490.7	–1018.0	–88.89	–660.0**	67.74	426.6**
VAT_minus	–27.33*	–122.2***	–66.48***	5.174	–79.22***	–110.0***	–47.03**	13.33	–61.06***	–6.555	–2.905	–2.572	–9.938***
π_nt_total	0.469	–4.325***	0.715	–1.944	0.659	–0.067	2.704	–1.405	–4.030	–4.509**	2.337	1.542	4.817*
π_nt_group	–1.885**	0.274	–4.609***	–4.896***	–2.102**	–1.692*	–2.411	–0.073	2.820*	2.061	–2.215**	–1.336	–3.711**
Trade	0.044	0.091	–0.626***	1.337***	0.198	0.421*	0.772	0.011	0.113	–0.155	–0.100	–0.002	–0.066
ln(T)	–0.277***	–0.277***	–0.016	–0.157	–0.292***	–0.324***	–0.077	–0.435***	–0.402***	–0.365***	–0.282***	–0.337***	–0.029
Dur1	–0.349***	–0.248**	0.162	0.338*	–0.199*	–0.382***	0.095	–0.506***	–0.377**	–0.335**	–0.164	–0.727***	–0.131
Dur2	–0.165**	–0.066	0.151	0.337**	–0.139*	–0.165*	0.082	–0.221*	–0.129	–0.167	0.036	–0.330**	0.028
Dur3	–0.100*	0.016	0.052	0.223**	–0.069	–0.072	0.106	–0.058	–0.067	–0.103	0.032	–0.384***	–0.015
Dur4	–0.055	0.026	0.036	0.135	0.038	–0.050	–0.077	–0.179*	–0.066	–0.145*	0.043	–0.548***	–0.018
Dur6	–0.048	0.051	0.040	–0.170*	0.021	–0.096	–0.066	–0.403***	0.202	0.013	0.058	–0.176	–0.080*
Dur9	0.053	–0.034	–0.129	–0.200	0.036	0.011	–0.294	0.018	0.329**	0.120	0.028	–0.096	0.009
Dur12	–0.008	0.057	–0.002	–0.081	0.014	0.152	–0.295*	–0.051	0.097	0.329**	0.157	0.048	0.073*
ATP	–0.067***	–0.005	0.031	–0.063***	0.013	–0.025	–0.222***	–0.099*	0.001	–0.058	0.011	–0.233***	–0.097*
ATP00	–0.230**	–0.147**	–0.352***	–0.050	–0.159**	0.025	0.092	–0.028	–0.145**	0.223***	–0.116***	–0.092	–0.177***
ATP50	–0.048	–0.141**	–0.188**	–0.058	–0.152	–0.096	–0.051	0.066	–0.524***	0.101	–0.237***	–0.070	–0.048
ATP95	–0.080	0.014	–0.104	0.050	0.051	0.006	0.157	0.179**	0.094	0.158	–0.019	0.111	–4.774***
ATP99	0.234***	0.077	0.039	0.119**	–0.056	0.046	0.462***	0.370***	0.158*	0.190***	0.258***	0.606	–0.580***
LDP	1.130***	1.400***	1.349***	0.138***	1.364***	0.960***	1.534***	0.993***	1.397***	–0.076	1.646***	–0.043	–0.671***
LDP*DW	–0.012	0.062**	–0.010	0.197***	0.097***	–0.221***	–0.025	0.463***	–0.019	0.061	0.163***	0.042	–0.096***
P_last	–0.015*	0.043***	0.025***	0.978***	–0.015***	0.036***	0.018**	0.006***	0.001***	0.002***	–0.001	0.020***	0.011***
Year2004	–0.193**	–0.175***	–0.398***	0.167***	–0.511***	–0.019	–0.010	–0.023	–0.057	–0.237***	0.108	–0.509**	–0.401
Year2005	–0.189**	–0.321***	–0.284***	0.085**	–0.347***	–0.070	–0.281	–0.173	0.011	–0.362***	–0.026	–0.696***	–0.106
Year2006	–0.201***	–0.177***	–0.187***	–0.019	–0.334***	0.021	0.049	0.069	–0.082	–0.344***	0.035	–0.901***	–0.091
Year2007	–0.302***	–0.262***	–0.323***	0.002	–0.421***	–0.055	–0.367**	–0.017	–0.153	–0.399***	–0.011	–1.146***	–0.187
Year2008	–0.156*	–0.220***	–0.058	–0.086**	–0.423***	0.074	–0.325*	0.120	0.049	–0.528***	–0.010	–0.695***	0.177
Year2009	0.285***	0.265***	0.294***	–0.057	0.069	0.277***	0.065	0.145	0.382***	–0.472***	0.308***	0.128	0.954***
Year2010	0.261***	–0.041	–0.089	–0.327***	–0.121**	0.007	0.428***	0.097	0.459***	–0.296***	0.354***	–0.167	0.853***
Year2011	0.205***	–0.042	–0.078	–0.165***	–0.360***	–0.102	0.129	–0.022	0.315**	–0.350***	0.188**	–0.408**	0.665***
Year2012	0.228***	–0.038	0.044	–0.256***	–0.190***	0.057	0.215	0.038	0.312**	–0.345***	0.355***	–0.458**	0.664***
January	0.048	0.074	0.043	0.013	–0.187***	–0.181***	0.021	0.193**	–0.317***	0.078	–0.139*	0.358**	0.300
February	0.062	0.100*	0.247***	–0.102**	0.051	0.050	–0.157	0.154*	–0.218**	0.046	–0.070	0.039	–0.342*
March	0.035	0.138***	0.242***	–0.224***	–0.005	0.001	0.036	–0.180*	–0.334***	0.283***	–0.212***	0.108	0.084

Table A8 (cont.)

	Bread and cereals	Meat and fish	Milk, cheese and eggs	Fruits and vegetables	Other food products	Non-alcoholic beverages	Alcohol and tobacco	Clothing and footwear products	Furnishing and household equipment products	Communi-cation, recreation and culture products	Other products	Restaurants and hotels	Other services
April	0.044	0.104*	0.237***	0.104**	–0.098*	–0.035	–0.293***	–0.456***	–0.257***	0.422***	–0.326***	0.129	–0.165
May	0.014	0.071	0.362***	0.124***	–0.073	–0.040	–0.219**	–0.280***	–0.399***	0.414***	–0.182***	0.297**	0.122
June	0.063	0.077	0.290***	0.215***	0.052	0.031	–0.286***	–0.185**	–0.246***	0.296***	–0.185***	0.097	–0.297*
July	–0.120**	–0.004	0.214***	0.495***	–0.097*	–0.244***	–0.185	–0.016	–0.482***	0.425***	–0.230***	0.253*	0.448***
August	–0.026	–0.074	0.149**	0.761***	0.049	–0.184***	–0.144	–0.082	–0.294***	0.291***	–0.121*	0.065	–0.254
September	–0.066	–0.080	0.058	0.423***	0.042	–0.061	–0.017	–0.662***	–0.313***	0.233***	–0.276***	0.384***	0.323*
October	0.006	–0.069	0.062	0.004	–0.125**	0.054	0.266**	–0.513***	–0.359***	0.169*	–0.080	–0.042	0.190
November	0.026	0.073	0.220***	–0.014	–0.078	0.009	0.058	–0.291***	–0.405***	–0.017	–0.227***	0.168	0.289
constant	–1.006***	–1.043***	–1.408***	–1.630***	–0.714***	–0.746***	–1.481***	–0.888***	–0.891***	–0.846***	–1.319***	–0.960***	–2.681***

Sources: CSB and authors' calculations.

Notes: *, ** and *** denote significance at 10%, 5% and 1% level respectively. Estimates of equation (5) are obtained by maximum likelihood using product weights in CPI basket. Coefficients before excise dummy variables for non-alcoholic beverages and alcohol and tobacco groups are not reported due to space constraint.

BIBLIOGRAPHY

AMEMIYA, Takeshi (1985) – *Advanced Econometrics*. Oxford : Basil Blackwell. 143 p.

AUCREMANNE, Luc, DHYNE, Emmanuel (2004) – *How Frequently do Prices Change? Evidence Based on Micro Data Underlying the Belgian CPI*. European Central Bank Working Paper Series, No. 331, April. 74 p.

AUCREMANNE, Luc, DHYNE, Emmanuel (2005) – *Time-Dependent versus State-Dependent Pricing: A Panel Data Approach to the Determinants of Belgian Consumer Price Changes*. European Central Bank Working Paper Series, No. 462, March. 68 p.

BAUDRY, Laurent, LE BIHAN, Herve, SEVESTRE, Patrick, *et al.* (2007) – What do Thirteen Million Price Records have to Say about Consumer Price Rigidity? *Oxford Bulletin of Economics and Statistics*, vol. 69, No. 2, April, pp. 139–183.

BAUMGARTNER, Josef, GLATZER, Ernst, RUMLER, Fabio, *et al.* (2005) – *How Frequently do Consumer Prices Change in Austria? Evidence from Micro CPI Data*. European Central Bank Working Paper Series, No. 523, September. 75 p.

BEŅKOVSKIS, Konstantīns, KALNBĒRZIŅA, Krista, FADEJEVA, Ludmila (2010) – *Price Setting Behaviour in Latvia: Descriptive Evidence from CPI Microdata*. *Latvijas Banka* Discussion Paper, No. 1. 58 p.

BENKOVSKIS, Konstantins, KALNBERZINA, Krista, FADEJEVA, Ludmila (2012) – Price Setting Behaviour in Latvia: Econometric Evidence from CPI Micro Data. *Economic Modelling*, vol. 29, issue 6, November, pp. 2115–2124.

BILS, Mark, KLENOW, Peter J. (2004) – Some Evidence on the Importance of Sticky Prices. *Journal of Political Economy*, vol. 112, issue 5, October, pp. 947–985.

CALVO, Guillermo A. (1983) – Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics*, vol. 12, issue 3, September, pp. 383–398.

CECCHETTI, Stephen G. (1986) – The Frequency of Price Adjustment: A Study of the Newsstand Prices of Magazines. *Journal of Econometrics*, vol. 31, issue 3, April, pp. 255–274.

DHYNE, Emmanuel, ÁLVAREZ, Luis J., LE BIHAN, Herve, *et al.* (2005) – *Price Setting in the Euro Area: Some Stylized Facts from Individual Consumer Price Data*. European Central Bank Working Paper Series, No. 524, September. 52 p.

GÁBRIEL, Péter, REIFF, Ádám (2010) – Price Setting in Hungary – A Store-Level Analysis. *Managerial and Decision Economics*, vol. 31, issue 2–3, March–April, pp. 161–176.

GREEN, William H. (2002) – *Econometric Analysis*, fifth ed. New Jersey : Pearson Prentice Hall. 1056 p.

HECKMAN, James J. (1979) – Sample Selection Bias as a Specification Error. *Econometrica*, vol. 47, No. 1, January, pp. 153–161.

HOFFMANN, Johannes, KURZ-KIM, Jeong-Ryeol (2006) – *Consumer Price Adjustment under the Microscope: Germany in a Period of Low Inflation*. European Central Bank Working Paper Series, No. 652, July. 109 p.

LÜNNEMANN, Patrick, MATHÄ, Thomas Y. (2005) – *Consumer Price Behaviour in Luxembourg: Evidence from Micro CPI Data*. European Central Bank Working Paper Series, No. 541, November. 62 p.

PUHANI, Patrick A. (2000) – The Heckman Correction for Sample Selection and its Critique. *Journal of Economic Surveys*, vol. 14, issue 1, February, pp. 53–68.

TAYLOR, John B. (1980) – Aggregate Dynamics and Staggered Contracts. *Journal of Political Economy*, vol. 88, issue 1, February, pp. 1–23.

WOOLDRIDGE, Jeffrey M. (2010) – *Econometric Analysis of Cross Section and Panel Data*, second ed. Cambridge : MIT Press. 1096 p.