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Food price responses to VAT changes: Price rigidity perspective from official and online data

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Abstract

This paper explores potential asymmetry and heterogeneity in price responses to two identical VAT shocks of opposite sign. To this end, we study how Polish food retailers reacted to a temporary VAT cut from 5% to 0% in February 2022 and its reversal in April 2024. Combining monthly CPI micro data together with high-frequency (daily) web-scraped prices allows us to identify price adjustments with greater precision and to distinguish immediate reactions from medium-term dynamics. We find that the VAT cut was passed through almost fully and immediately across all retailers via a sharp increase in the frequency of price decreases. By contrast, the VAT increase generated only partial and heterogeneous pass-through: among small retailers it was immediate and complete, whereas large retailers raised their prices only modestly on impact and continued to do so with a delay. To rationalize this key asymmetry in prices response, we outline a simple framework in which price hikes trigger psychological menu costs—stemming from consumer loss aversion and customer anger—while price cuts do not, leading to weaker and delayed pass-through of VAT increases.

JEL classification: D40; E31.

Keywords: price rigidity; VAT rate change; pass-through; individual prices; web-scraped prices.

1. Introduction

Do prices respond asymmetrically and heterogeneously across retailers to identical VAT shocks of opposite sign? To answer this question, we study how the temporary reduction of the VAT rate on basic food products from 5% to 0% on February 1st, 2022, and its subsequent reversal back to 5% on April 1st, 2024, affected consumer food prices in Poland.

To this end, we compute a range of price-setting statistics and trace their evolution in the months preceding and following both policy interventions. These measures are derived from a large micro-dataset of unit price quotes used in the computation of the Consumer Price Index (CPI). To sharpen our conclusions, we complement our results with evidence drawn from high-frequency web-scraped prices gathered from both small and large retailers.

Following the surge in inflation after the Covid-19 pandemic and the outbreak of the full-scale Russian invasion of Ukraine, many countries introduced anti-inflationary measures (Sgaravatti et al., 2021) in order to shield households from rapid price increases and to prevent inflation expectations from rising excessively, which could trigger spiral effects. Poland was no exception. Inflationary pressures—primarily of external origin (Szafranek et al., 2024)—led to a substantial rise in prices, prompting the government to adopt a broad set of temporary interventions, including tax reductions, price caps, and subsidies. Among these measures, the reduction of the VAT rate on basic food products was the principal tool directly affecting the food market. The propagation mechanism of this intervention to consumer food prices is the focus of our analysis.

The VAT cut and its later reversal create a natural setting to examine how retailers adjust prices in response to tax changes of identical magnitude but opposite sign in a sector fully determined by market forces. Unlike in regulated or tax-dependent markets, where administrative decisions translate almost mechanically into final prices, the pass-through of VAT changes in the retail food sector depends entirely on firms' pricing behaviour and competitive conditions. Whether the recent VAT changes were passed through to consumers—and whether the responses to the reduction and the reversal were homogenous across retailers—are the central questions addressed in this paper.

The literature on the pass-through of VAT changes to consumer prices is extensive but far from reaching a consensus (see the review in Section 2). In this context, we study the Polish case using a price-setting perspective. A key contribution of our analysis is that it combines findings from two independent and complementary datasets on consumer prices. First, we employ a large database of granular monthly unit prices for food and non-alcoholic beverages collected by Statistics Poland and used in the construction of the CPI, which allows us to track the evolution

of key price rigidity metrics around both VAT interventions. Second, to complement the monthly evidence, we re-examine this issue using a rich dataset of high-frequency (daily) web-scraped retail prices that we collected, which provide a more detailed and nuanced picture on how retailers adjusted prices in the immediate vicinity of the policy changes.

To the best of our knowledge, this is the first study to combine two data sources—official CPI microdata and independently collected web-scraped price data at different frequencies—thereby providing a richer and more comprehensive view of price formation around tax changes.

Our paper makes four distinct contributions to the literature on VAT incidence and price-setting dynamics. First, we provide the most granular analysis of VAT pass-through in Poland to date, using a unique combination of monthly CPI microdata and daily web-scraped prices from several retailers. This data architecture allows us to study both the immediate and medium-term effects of VAT changes, while mitigating temporal aggregation biases that typically arise in studies relying solely on monthly data. By incorporating high-frequency data, we contribute high-resolution evidence to a literature that often draws inference from lower-frequency data. More broadly, we show that complementing traditional CPI microdata with non-traditional sources—such as web-scraped prices—yields additional and novel insights into price-setting behaviour that cannot be uncovered using standard data alone.

Second, we contribute to the debate on whether the VAT pass-through is complete or partial, and whether retailers respond symmetrically to tax hikes and cuts. Our findings reveal a clear pattern: the VAT reduction generated widespread and immediate price decreases across all retailers, whereas the VAT increase was transmitted immediately and fully across small retailers, but only partially and with a delay among large retailers. This asymmetry provides a new empirical counterpart to theoretical work highlighting the role of consumer loss aversion, tax salience, and competitive pressures in shaping pass-through. In doing so, our findings complement both studies that document immediate and full pass-through, as well as those reporting asymmetries or delayed responses.

Third, our study adds to the growing literature on heterogeneous price-setting behaviour. By distinguishing between small and large retailers, we demonstrate that market structure and behavioural considerations jointly shape price responses to the tax shocks. Large retailers appear especially reluctant to raise prices immediately after the VAT reversal—consistent with concerns about customer anger and reputational loss—while small retailers pass through tax increases more

directly as they are not under close scrutiny.¹ This evidence links the VAT pass-through literature to the broader research on retail competition, behavioural industrial organisation, and the microfoundations of inflation dynamics.

Fourth, we complement our empirical analysis with a simple conceptual model of price-setting that incorporates psychological menu costs—that is, additional behavioural frictions arising from consumers’ asymmetric reactions to price changes. The model extends the standard menu-cost framework by allowing the effective cost of a price increase to exceed that of a price decrease due to anticipated customer anger, loss aversion, and heightened consumer attention during inflationary periods. This behavioural augmentation generates an asymmetric adjustment threshold: firms readily implement large and salient price reductions, but they delay or attenuate price increases unless the underlying shock is sufficiently strong. The model therefore helps illustrate theoretically the key patterns we document empirically—immediate and nearly complete pass-through of the VAT reduction and a markedly weaker and gradual pass-through of the VAT increase, especially among large retailers—and provides a unified mechanism linking consumer psychology, market competition, and firms’ pricing decisions. As such, the model serves as an illustrative mechanism showing how consumer psychology and competitive considerations could give rise to the observed asymmetries, without claiming to uniquely identify the underlying driver of firms’ pricing behaviour.

The rest of the paper is structured as follows. Section 2 reviews the relevant literature. Section 3 describes the datasets and outlines the empirical methodology. Section 4 presents the main results based on monthly CPI micro data and high-frequency prices, examines heterogeneity across retailers, develops a simple theoretical model with psychological menu costs that helps rationalise the observed pricing behaviour and provides a discussion. Section 5 concludes.

¹ Stelmasiak et al. (2024) document a similar case, in which food prices have responded only weakly to a large supply shock during the initial phase of the Covid-19 pandemic.

2. Literature review

The literature on the pass-through of VAT changes to consumer prices is extensive but far from consensus. Most studies estimate the pass-through using dynamic difference-in-differences or event-study models, yet their conclusions differ markedly. Some contributions find that pass-through tends to be partial (e.g., Kosonen, 2015; Buettner and Madzharova, 2021; Fabo et al., 2025; Fuest et al., 2025), whereas others document complete or nearly complete transmission (e.g., Jaworski and Olipra, 2025; Forteza et al., 2025; Bernardino et al., 2025). A similar disagreement concerns the symmetry: while some studies report symmetric effects for VAT reductions and reversals (e.g., Bernardino et al., 2025; Bedenek et al., 2020), others uncover clear asymmetries, with price responses differing substantially depending on whether the tax rises or falls (e.g., Karadi and Reiff, 2019; Benzarti et al., 2020).

A growing body of work shows that the degree of the pass-through can depend on market and product characteristics. Pass-through varies with product attributes (e.g., Forteza et al., 2025; Bedenek et al., 2020), the degree of competition in the market (Dimitrakopoulou et al., 2024), the asymmetry of information between sellers and buyers and the market structure (Bellon et al., 2024), the duration of the policy intervention (Bernardino et al., 2025), and whether the policy affects standard or reduced VAT rates (Bedenek et al., 2020). These factors highlight the importance of market design and behavioural frictions in shaping the incidence of consumption taxes.

Recent work leveraging high-frequency price data—mostly web-scraped datasets and scanner data—has substantially improved the empirical precision in measuring the VAT pass-through. Because these data avoid temporal aggregation bias, the estimated responses tend to be more accurate. Several recent studies document that the price response to VAT changes is immediate or almost immediate (e.g., Bernardino et al., 2025; Forteza et al., 2025). This stands in contrast to the evidence based on monthly data, which often suggests a gradual adjustment (e.g., Forteza et al., 2025; Jaworski and Olipra, 2025). In some settings, retailers even adjust prices in anticipation of the tax change when it is pre-announced (Buettner and Madzharova, 2021).

Within this strand, Bernardino et al. (2025) study Portugal's temporary VAT cut using high-frequency prices and show that the pass-through was immediate and complete, with a symmetric reversal. The authors argue that tax salience, extensive media coverage, institutional oversight, and a deflationary trend in food producer prices all facilitated full pass-through. Forteza et al. (2025), using daily web-scraped data for Spain, find that the pass-through reached nearly 90% after two weeks, with some products adjusting fully within two days. They also document

noteworthy asymmetry: the VAT-induced price reduction was much larger than the subsequent price increase after the VAT hike, contrary to the pattern documented by Benzarti et al. (2020). Fabo et al. (2025) examine scanner data for Slovakia and find large heterogeneity across products, which they attribute to differences in product characteristics, demand elasticity, and policy design.

The paper most closely related to ours is Jaworski and Olipra (2025), who analyse the Polish VAT cut using HICP data. They conclude that pass-through was limited on impact but nearly complete after six months. However, their estimates exhibit wide uncertainty bands—ranging from 20% to 90% immediately and 20% to 170% after six months—highlighting the imprecision inherent in monthly data.² Forteza et al. (2025) similarly stress that monthly estimates of VAT pass-through have large standard errors and can be highly sensitive to model specification.

Our analysis also relates to Karadi and Reiff (2019), who use Hungarian micro-price data to document that prices respond flexibly and asymmetrically to positive and negative tax shocks. They find that tax increases generate much larger spikes in the frequency of price adjustments than tax cuts, and that price changes become smaller and more concentrated during such episodes. Conversely, Buettner and Madzharova (2021) show that pass-through in Germany typically becomes complete within four months, but also that firms adjust prices ahead of time when policy changes are announced sufficiently early.

Finally, this paper is linked to the broader literature that studies price-setting using large CPI micro datasets. Seminal contributions include Bils and Klenow (2004), Klenow and Krytsov (2008), and Nakamura and Steinsson (2008) for the U.S., and Álvarez et al. (2006) and Dhyne et al. (2005, 2006) for the euro area.³ More recent studies include Gautier et al. (2024, 2026) for selected euro-area countries⁴ and Macias et al. (2026) for Poland. Our methodology closely follows this tradition by computing detailed price-setting statistics at both monthly and daily frequencies to re-examine VAT pass-through in Poland.

² Extremely large confidence bands are also visible for the estimates at the lower level of aggregation within the food and non-alcoholic beverages subdivision.

³ A broad overview of the contributions from the early literature is provided by Klenow and Malin (2010). More recently, research has examined price formation across different inflationary environments for example, in Argentina (Alvarez et al., 2019), Mexico (Gagnon, 2009), Norway (Wulfsberg, 2016), France (Berardi et al., 2015) and Poland (Macias et al., 2026), where further references to country-specific evidence can be found.

⁴ Gautier et al. (2024) and Gautier et al. (2026) document price formation in eleven euro area countries within a harmonized exercise conducted on a comprehensive dataset of granular price data during periods of low and high inflation, respectively.

3. Data and methodology

We begin by describing the two granular, micro-level datasets of consumer prices used in the analysis. The first subsection outlines their structure, coverage, and key features. In the following subsection, we discuss the methodology employed to calculate price rigidity statistics, including measures of frequency and size of price changes.

3.1. Data

Monthly dataset. We begin the analysis using individual price quotations collected from retail outlets across Poland. These prices are gathered by Statistics Poland on a monthly basis and subsequently used to compute the consumer price index (CPI). Yearly datasets have been kindly provided by the statistical office, for which we are very grateful.

Granular data on prices of all consumer goods and services are internally consistent withing each year as some minor changes occur between annual samples.⁵ Therefore, in the first step, we match series of prices of representative products across the entire sample to create a coherent panel structure. The full dataset covers the period from January 2014 to December 2024. From this dataset, we extract prices for all food and non-alcoholic beverages, which constitute the basis for our analysis of price formation around the VAT rate changes. After applying this selection, the dataset contains nearly 29 million individual price quotes for approximately 500 representative food products, recorded each month in up to 210 locations.

To clean the data, first we remove all instances where only average prices or price indices are reported.⁶ Second, we eliminate outliers defined as price reductions exceeding 80% or a price increases greater than 400%.⁷ These steps do not affect the completeness of our database. Since Statistics Poland already accounts for quantity adjustments, there is no need to control for the variation in the size of packaging over time to capture the “true” price change.

⁵ These include updates to the product basket or sampling procedures.

⁶ Beside traditional data, Statistics Poland also uses scanner data and online prices to calculate food and non-alcoholic beverages inflation. We exclude them because they enter the database in the form of price indices rather than individual prices. However, evidence from the literature suggests that online and offline prices exhibit very similar dynamics (Macias et al., 2023; Szafranek et al., 2025). Consequently, the basic characteristics of the price-setting process should be similar as well.

⁷ Setting thresholds for outlier removal is standard in the literature. The ones used are adopted from Macias et al. (2026), who provide a detailed analysis of price rigidities in Poland.

Given that the reduced VAT rate was introduced for basic food products, we identify and select the elementary groups⁸ that include the products affected by the policy change and label them as “treated”.⁹ On average, these groups account for roughly 82% of the food and non-alcoholic beverages subdivision. Accordingly, the remaining part of the food basket is labelled as “untreated”. Using these data, we compute price-setting statistics around the VAT policy change.

High frequency dataset. Since daily data can sharpen the identification of the impact of policy shocks on consumer prices and may provide a better understanding of the change in the pricing strategies, we also use a second dataset of daily web-scraped prices. Specifically, we employ an extensive E-CPI dataset on food prices, courtesy of Narodowy Bank Polski. The dataset contains prices of individual products collected through web scraping from 12 grocery retailers in Poland over the period 2021-2024. Specifically, in February 2022 and in April 2024 the number of price quotations exceeds 2 million per month, while the number of observed unique food products exceeds 100 thousand. Due to the meticulous product selection¹⁰ the effective sample size amounts to more than 30 thousand of products per month. Prices are typically gathered from Monday to Friday. They are used to compute the same measures of price-setting as the monthly dataset (cf., Section 3.2.) as well as inflation at the daily frequency.¹¹

Since this dataset allows us to differentiate between retailers, we explore whether they respond homogeneously to the policy intervention. Cavallo (2017) shows that while within-retailer price

⁸ The so-called elementary group is the lowest level at which prices of consumer goods and services are aggregated within the CPI basket. It typically gathers most homogenous products.

⁹ These are basic food products as follows: 01.1.1 - bread and cereals, 01.1.2 - meat, 01.1.3 – fish and seafood, 01.1.4 – milk, cheese and eggs, 01.1.5 – oil and fats, 01.1.6 - fruit, 01.1.7 - vegetables, 01.1.8.2 – jams, marmalades and honey, 01.1.8.5 – edible ices and ice cream, 01.1.9.3 - baby food, 01.2.2.3 – fruit and vegetables juices. At the same time, the reduced VAT rate was not applied primarily to highly processed products that are not essential to the diet (e.g. carbonated beverages and confectionery).

¹⁰ For a detailed description of the dataset and product selection procedure, we refer to Macias and Stelmasiak (2019), Macias et al. (2023), and Szafranek et al. (2025). In short, product selection aims at obtaining more representative sample in terms of product varieties resembling representative products established by the statistical office.

¹¹ Since data for Saturdays and Sundays are missing for some part of the E-CPI dataset, we remove all weekends to ensure better comparability in the analysis of VAT changes. For the calculation of daily frequency of price changes, we require no more than three consecutive days of data to be missing. This assumption covers weekends, public holidays, and most of missing observations caused by web-scrapers failures (which are common in such procedures). As for weekends, this data treatment introduces a ‘Monday effect’, as Monday prices are typically compared with those from the preceding Friday. This effect can be readily removed using a seasonal adjustment procedure.

heterogeneity tends to be small or negligible, across-retailer heterogeneity is considerable, and the price-setting process is not synchronized across sellers. We test whether this pattern holds also in the context of the VAT rates changes. To this end, we divide retailers into two groups based on their annual revenues: “large” and “small”. The first group consists of three retailers—both brick-and-mortar and online—with annual revenues exceeding PLN 10 billion. The remaining retailers are classified to the latter group, as they are considerably smaller in terms of size and assortment. This subsample also includes several very small, purely e-commerce retailers with annual revenues below PLN 500 million.

3.2. Methodology

To study how the price formation process was affected during the policy intervention, we analyse unit-level prices through the lens of the frequency of price changes. This framework is widely used in the literature on price rigidity, as discussed in Section 2.

Using granular price datasets—retail-outlet data compiled by Statistics Poland and web-scraped data collected by NBP—we compute several key statistics describing the price formation process: the frequency of price increases and decreases, and the average sizes of those adjustments. These indicators are calculated for all elementary groups within the food and non-alcoholic beverages division (i.e., at the two-digit COICOP level¹²).

At the product level, we follow the practice of the Statistics Poland and aggregate these statistics using arithmetic mean. Next, at the elementary-group level we apply the CPI weighing system to obtain aggregate measures for the treated and untreated product groups.

Below, we present all formulas used in this study, following the approach of Macias et al. (2026). For monthly data, we present the price-setting process within a window of six months before and after each policy intervention undertaken by the Polish government. For the daily data, we set a shorter horizon, examining up to three months on either side of the intervention dates.

¹² COICOP stands for the Classification of Individual Consumption by Purpose. It classifies consumer expenditures and is used for the compilation of the Consumer Price Index.

To calculate the frequency of the price change, we start by denoting P_{ijt} as the price of i -th individual product assigned to the representative item j at time t (day or month). Based on these prices, we construct the indicator variable x_{ijt} , which equals 1 if both P_{ijt} and P_{ijt-1} were observed and 0 otherwise:

$$x_{ijt} = \begin{cases} 1 & \text{if } P_{ijt} \text{ and } P_{ijt-1} \text{ are observed,} \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

We then define another indicator variable z_{ijt} , which takes the value of 1 if the price of product i assigned to the representative item j changes between $t - 1$ and t and the value of 0 otherwise:

$$z_{ijt} = \begin{cases} 1 & \text{if } P_{ijt} \neq P_{ijt-1} \wedge x_{ijt} = 1, \\ 0 & \text{otherwise.} \end{cases} \quad (2)$$

We also define two additional indicator variables, w_{ijt} and s_{ijt} , which identify price increases and decreases, respectively:

$$w_{ijt} = \begin{cases} 1 & \text{if } P_{ijt} > P_{ijt-1} \wedge x_{ijt} = 1, \\ 0 & \text{otherwise,} \end{cases} \quad (3)$$

$$s_{ijt} = \begin{cases} 1 & \text{if } P_{ijt} < P_{ijt-1} \wedge x_{ijt} = 1, \\ 0 & \text{otherwise.} \end{cases} \quad (4)$$

Using the variables defined in equations (1)-(4), we calculate the frequency of price changes f_{jt} , the frequency of price increases f_{jt}^+ , and the frequency of price decreases f_{jt}^- for the representative item j at time t . These are given by:

$$f_{jt} = \frac{\sum_{i=1}^{n_j} z_{ijt}}{\sum_{i=1}^{n_j} x_{ijt}}, \quad (5)$$

$$f_{jt}^+ = \frac{\sum_{i=1}^{n_j} w_{ijt}}{\sum_{i=1}^{n_j} x_{ijt}}, \quad (6)$$

$$f_{jt}^- = \frac{\sum_{i=1}^{n_j} s_{ijt}}{\sum_{i=1}^{n_j} x_{ijt}}. \quad (7)$$

In all cases, n_j denotes the number of individual products assigned to the representative item j at time t .

Next, we compute the average size of price changes, increases and decreases. Let dp_{ijt} denote the change in the price of product i between $t - 1$ and t :

$$dp_{ijt} = \frac{P_{ijt} - P_{ijt-1}}{P_{ijt-1}}. \quad (8)$$

The average size of price changes, increases and decreases for the representative item j at time t is calculated as:

$$dp_{jt} = \frac{\sum_{i=1}^{n_j} dp_{ijt} z_{ijt}}{\sum_{i=1}^{n_j} z_{ijt}}, \quad (9)$$

$$dp_{jt}^+ = \frac{\sum_{i=1}^{n_j} dp_{ijt} w_{ijt}}{\sum_{i=1}^{n_j} w_{ijt}}, \quad (10)$$

$$dp_{jt}^- = \frac{\sum_{i=1}^{n_j} dp_{ijt} s_{ijt}}{\sum_{i=1}^{n_j} s_{ijt}}. \quad (11)$$

As mentioned earlier, when aggregating statistics from the product level to the division level, we follow the approach by Statistics Poland. Accordingly, to obtain measures at the elementary group level—typically comprising several representative items—we compute unweighted averages of item-level frequencies and sizes of prices changes:

$$f_{kt} = \frac{\sum_{j=1}^J f_{jt}}{J}, \quad (12)$$

$$dp_{kt} = \frac{\sum_{j=1}^J dp_{jt}}{J}, \quad (13)$$

where J is the number of the representative items belonging to the elementary group k at time t . The same aggregation procedure is applied to the frequencies and sizes of price increases and decreases.

At the aggregated level, we employ the CPI weighing system used by Statistics Poland. This approach is standard in studies on price rigidity, although some authors opt to average weights over time or keep them constant (e.g., Dhyne et al., 2006; Gautier et al., 2024, Gautier et al., 2026). This weighted aggregation can be described as follows:

$$\bar{f}_t = \sum_{k \in K} \omega_{kt} f_{kt} \quad (14)$$

$$\overline{dp}_t = \sum_{k \in K} \omega_{kt} dp_{kt} \quad (15)$$

where ω_{kt} denotes the weight of elementary group $k \in K$ at time t , which are updated at an annual frequency by Statistics Poland. In our setting, $\bar{f}_t$ and $\overline{dp}_t$ represent the average frequency and size of price changes for either the treated or untreated group.

4. Results

This section brings together all empirical results. We begin by discussing the outcomes obtained from the monthly dataset. We then complement these findings with evidence based on the daily data. Next, we explore potential heterogeneity in the pricing behaviour across retailers. Finally, we provide a discussion of the results and rationalize them with the means of a simple economic model accounting for psychological menu costs.

4.1. Evidence from official monthly data

We start our analysis with the relevant metrics derived from monthly data. Figure 1 illustrates evolution of the frequencies of price increases and decreases around the VAT rate reduction on February 1st, 2022 (column A) and its reversal on April 1st, 2024 (column B).

Following the VAT reduction (column A), the frequency of price decreases for the treated products (black line) rises sharply in February 2022, reaching 50%. No comparable response is observed for the untreated products (red line), whose frequency of price decreases remains close to its usual level. At the same time, the frequency of price increases remains essentially unchanged for both treated and untreated products immediately after the tax cut. In the months that follow, however, the frequency of price increases gradually rises for both groups, with a noticeably stronger increase for the treated products. This pattern suggests that retailers faced upward cost pressures—likely related to the full-scale Russian invasion of Ukraine—and raised prices accordingly, offsetting part of the initial tax-induced reductions. Overall, the figure does not support the interpretation that retailers passed through the VAT reduction only after a long delay as argued by Jaworski and Olipra (2025). Instead, the immediate drop in the treated group indicates a rapid reaction.

Following the VAT rate reversal (column B), the frequency of price increases rises sharply for the treated products, although the peak is somewhat smaller than the one observed after the VAT reduction (47% vs 50%). Unlike during the reduction episode, this elevated frequency does not return to its typical level immediately. Instead, it remains above this level for two additional months. This pattern suggests that retailers postponed some of the price increases triggered by the VAT change and implemented them gradually. No such persistence is visible for the untreated products, although their frequency of price increases also rises modestly around the reversal, indicating that retailers used the VAT change as an opportunity to adjust other prices as well, albeit to a smaller degree. By contrast, the frequency of price decreases moves similarly for treated and untreated products after the reversal, with no meaningful divergence between the two groups.

Figure 2 presents the average size of price increases and decreases around the VAT rate reduction on February 1st, 2022 (column A) and its reversal on April 1st, 2024 (column B). Overall, the figure shows that VAT changes affected the size of price adjustments far less than their frequency. Following the VAT reduction (column A), the average size of price decreases for treated products (black line) falls noticeably at the moment of the tax cut, after having edged up slightly in the preceding months. For untreated products the size of price decreases remains relatively stable (red line). The average size of price increases also shows no abrupt change for either group at the time of the VAT reduction. Around the VAT reversal (column B), the average size of price decreases for treated products shows a modest decline after the policy change, with slight increase beforehand. For untreated products, a decline is also visible, but it is very small, and the preceding increase is noticeably weaker than for the treated group.

These patterns indicate that retailers primarily responded to the VAT interventions by adjusting how often they changed prices rather than how much they changed them by. This mechanism is intuitive: when the frequency of price changes strongly rises, individual adjustments tend to be smaller. Our findings are consistent with Karadi and Reiff (2019), who also document that in months with tax changes, price adjustments became smaller.

4.2. Evidence from high-frequency web-scraped price data

We turn our attention to the evidence from web-scraped, high-frequency price data. Figure 3 presents daily frequencies of price increases and decreases across the whole group of retailers around the reduction of the VAT rate on February 1st, 2022 (column A) and the reversal of the VAT rate on April 1st, 2024 (column B) for the treated and untreated product groups (black and red lines, respectively).¹³ The high-frequency data reveal even more clearly that retailers responded immediately to the policy changes.

Around the VAT reduction (column A), the frequency of price decreases for treated products spikes sharply on the day the lower VAT rate takes effect, reaching 56%.¹⁴ This reaction is both immediate and short-lived. Untreated products show no response, with their frequency of price decreases remaining near zero throughout the window. The frequency of price increases shows no noticeable movement for either group, confirming that the adjustment to the tax cut operated

¹³ Since April 1st, 2024, fell on Easter Monday—a national holiday when stores are closed—the first business day after the VAT reversal for which data are available, is April 2nd, 2024.

¹⁴ We also note that on February 2nd, 2022, the frequency of price decreases remains elevated (at 22%). This could be related to the fact that some retailers might adjust their prices during the day. In such cases, the price change—at daily frequency—is observed on the following day.

almost exclusively through price reductions. Apart from this episode, the frequencies of price increases and decreases evolve very similarly, indicating that the observed discrepancy is purely due to the policy change. Around the VAT reversal (column B), we again observe an immediate jump in the frequency of price increases for the treated products which is somewhat smaller than in case of the VAT reduction, peaking at 52%. In turn, untreated products display only a minor increase. This points to only weak asymmetry. Again, apart from this short time period, the frequencies of price increases and decreases evolve very similarly.

Taken together, the daily data provide strong confirmation of the patterns observed in the monthly analysis. Retailers respond to VAT changes almost instantaneously, and the adjustment occurs primarily through changes in the frequency of price updates rather than in their magnitude. At the same time, and contrary to the monthly data, the asymmetry between the response to the VAT reduction and its reversal is much less pronounced in the high-frequency evidence. This raises the question whether retailers indeed attempted to withhold—at least initially—the increase in prices following the reversal, as the monthly data might suggest.

4.3. Heterogeneity in retailers' pricing policy

To shed further light on whether retailers attempted to withhold—at least initially—the increase in prices following the VAT reversal, we distinguish between small and large retailers in our sample. Figure 4 plots again the frequencies of price increases and decreases around the two VAT rate changes (column A and B, respectively) for the treated product groups, separately for small and large retailers (black and red lines, respectively). For each date, we report the maximum of each metric within each retailer-size category.

The figure shows that, at the peak of the response to the VAT reduction, prices of nearly all treated products fall. Among small retailers, the frequency of price decreases spikes to 96.4% on February 1st, while for large retailers it reaches 88.7%. The reaction during the VAT reversal, however, exhibits much stronger heterogeneity. The share of price increases among small retailers rises sharply—to 92.1% on the first business day of April 2024—whereas for large retailers the corresponding share amounts to only 41.4%. This pattern is consistent with public announcements made by some large retailers, who stated that they would not raise prices after the VAT reintroduction.

Another noteworthy feature is that the frequency of price increases among large retailers rises atypically in the second half of April (to below 20%) and remains elevated for several days. We

also identify two pronounced spikes in the frequency of price increases in May¹⁵ (to 47.4% and 37.3%), each attributable to a different retailer. These delayed adjustments suggest that large retailers postponed price increases following the VAT rate hike—likely to avoid “customer anger” and to maintain price attractiveness in a highly competitive retail environment. Notably, these spikes in May correspond closely to the elevated frequency of price increases observed in the CPI monthly data.

To complement our analysis of price-setting frequencies, next we assess the cumulative price change following each VAT intervention. Figure 5 shows the development in the average level in prices of treated products across all retailers over the first five days after the VAT rate reduction (panel A) and its reversal (panel B), plotted against retailer revenues.¹⁶

Following the VAT reduction (panel A), prices in most stores fell by more than 4.5%, indicating either a near complete or a complete pass-through of the tax cut.¹⁷ Heterogeneity across retailers is limited. Only one small retailer records a smaller reduction of about 3%, suggesting that part of the tax cut may have been absorbed in its mark-ups. The remaining retailers reduce prices more substantially, with larger ones cutting slightly more, implying that they did not risk passing through less than the full amount of the VAT reduction. Consequently, the fitted trend line in panel A in Figure 5 is only slightly downward-sloping.

The response to the VAT reversal (panel B) differs markedly. We uncover a substantial heterogeneity in the pass-through, both within retailer groups and across them. While the average price increase in the treated products amounts to 4.8%, individual retailers exhibit a wide range of responses—from as little as 0.8% to more than 7.0%. This pattern suggests that while some retailers did not fully increase prices by the expected 5% on impact, others appear to have used the opportunity to increase their mark-ups. This behaviour is particularly evident among the smallest retailers in our sample, for whom the average immediate price increase amounts to

¹⁵ In early May 2024, one of the retailers increased 47.4% of prices in the treated products group, compared with 12.3% in the untreated group. Another retailer raised 37.3% of prices in late May in the treated group, versus only 8.9% in the untreated group.

¹⁶ For calculating the pass-through of the VAT rate changes based on the daily data, we assume that no other factors influenced the price formation, which is highly plausible given the evidence on price frequencies. Hence, we calculate the price change cumulated over the very first few days after the VAT change. In doing so, we provide an alternative, data-driven evidence of the immediate pass-through, without relying on event-study models and their underlying assumptions.

¹⁷ With the VAT rate lowered from 5% to 0%, the price level should fall by approximately 4.8%. In practice, however, some retailers could still target a 5% reduction.

6.0%¹⁸. The situation looks different for large retailers. Their prices barely change immediately: the largest retailer in our sample raises its prices by only 0.8% on average (-0.1% based on non-seasonally adjusted data). This divergence is reflected in the markedly steeper, downward-sloping trend line in panel B of Figure 5.

We formally investigate the heterogeneous effect of VAT rate changes across small and large retailers on price changes (i.e., daily inflation) using a fixed-effect panel model. The aim of this exercise is to quantify whether the immediate reaction to the VAT reduction and its reversal differed systematically across retailer types, and to test whether small and large retailers followed distinct pricing policies in the days surrounding each policy intervention. To this end, we estimate the following equation:

$$\pi_{it} = \beta_1 D^S V^- + \beta_2 D^L V^- + \beta_3 D^S V^+ + \beta_4 D^L V^+ + \sum_{k=1}^4 \alpha_k D_k + \gamma_1 e_t + \mu_i + \varepsilon_{it} \quad (16)$$

where: π_{it} denotes the price change (inflation) at store i and day t ; D^S and D^L are dummy variables taking the value of 1 for small and large retailers, respectively; V^- and V^+ are dummy variables taking the value of 1 in the first five days after the VAT cut and the VAT hike, respectively; D_k is a day-of-week dummy variable (from Monday to Thursday, with Friday as the base category) to account for daily seasonality; e_t is the log growth rate in the EUR/PLN exchange rate; μ_i captures the unobservable store-level heterogeneity; and ε_{it} is the remaining error term. The panel is unbalanced, which is standard given the nature of the data, and covers $i = 1, \dots, 12$ retailers and $t = 1, \dots, 1008$ days.¹⁹

Following the estimation, we also conduct two sets of parameter-equality tests. First, we examine whether small and large retailers react similarly to the VAT reduction and VAT reversal by testing $\beta_1 = \beta_2$ for the VAT reduction and $\beta_3 = \beta_4$ for the VAT reversal. Second, we test whether retailers within each size group behaved similarly across the two policy changes by evaluating $|\beta_1| = |\beta_3|$ for small retailers and $|\beta_2| = |\beta_4|$ for large retailers. Under each null hypothesis, the

¹⁸ Although for the overall *food and non-alcoholic beverages* category (C01) this figure amounts to only 5.2%. It cannot be ruled out that small retailers took the opportunity to effectively shift the tax burden to the untreated products as well.

¹⁹ The unbalanced nature of the panel is typical in empirical economic applications, particularly when working with web-scraped data. There are at least two main reasons for it. First, firms may enter or exit the market over time. This is the case of the largest retailer in our sample, which launched its online store in early 2024. Second, data for specific retailers may occasionally fail to be collected or processed correctly on certain days, leading to missing observations. For a more extensive discussion of unbalanced panels, see Baltagi et al. (2021).

test statistics follows F-distribution with 1 and 11 degrees of freedom. In all estimations we rely on cluster-robust HC3 standard errors.

Table 1 reports the estimation results. The impact of both the VAT decrease and the VAT increase on inflation across small retailers (captured by β_1 and β_3) is statistically significant at the 1% level. The effect of the VAT decrease among large retailers (β_2) is likewise significant at 1% level. By contrast, the immediate inflation response among large retailers following the VAT reversal (β_4) is considerably weaker and marginally significant only at the 10% level.²⁰

The equality tests show that small and large retailers reacted similarly to the VAT reduction—prices of treated products changed comparably in both groups, as we are unable to reject the null hypothesis $\beta_1 = \beta_2$ at any conventional significance level. The picture changes, however, for the VAT reversal. Here, the null hypothesis $\beta_3 = \beta_4$ is strongly rejected, indicating clear heterogeneity in the prices response between small and large retailers.

We turn to the second equality test, which examines whether the immediate response of retailers within the same size category was symmetric to the VAT decrease and the VAT increase. For small retailers, we can only tentatively reject the null hypothesis $|\beta_1| = |\beta_3|$ at the 10% significance level. For large retailers, however, the null $|\beta_2| = |\beta_4|$ is rejected more clearly at the 5% confidence level, indicating that their reaction to the VAT reversal was significantly weaker than their reaction to the VAT cut. Therefore, while small retailers appear to have responded symmetrically to both policy changes, this is not the case for large retailers.²¹ This outcome further validates our findings from the analysis of price rigidities: the immediate reaction of larger retailers appears to have been driven by a desire to remain competitive, leading them to change prices as little as possible after the VAT increase.

²⁰ We also observe a statistically significant “Monday effect” in our data, whereas seasonality on other days of the week is not present.

²¹ One might be concerned that this results are driven by the presence of the very large retailer in the sample. However, this is not the case. When we re-estimate the model excluding this retailer, the results remain qualitatively unchanged: the responses of small (large) retailers to the VAT decrease and the VAT increase continue to be symmetric (asymmetric). Furthermore, inflation reacts similarly across retailers when the VAT rate decreases, while after the VAT increase the difference in price responses between large and small retailers persists and even becomes slightly larger for the group of large retailers compared with the baseline specification. These additional results are available upon request.

4.4. Discussion

Our results reveal a clear asymmetry in how small and large retailers reacted to the decrease and subsequent increase in the VAT rate. While the VAT reduction was passed through almost fully and immediately across all retailers, the VAT increase no longer produced an immediate symmetric response. In particular, large retailers postponed raising prices and transmitted only part of the tax shock. Below, we discuss several mechanisms that may explain these findings and outline their implications for price-setting behaviour and macroeconomic policy.

A first explanation relates to the competitive structure of the Polish retail market. Although the sector has become more concentrated, competition remains exceptionally strong, and retailers frequently engage in “price wars”. In such an environment, firms are highly sensitive to the risk of customer defection. Microeconomic studies show that consumers react disproportionately strongly to price increases, especially when they perceive them as unfair or opportunistic—reflecting *customer anger* or *fairness concerns* (see, for example, Homburg et. al., 2005; Anderson and Simester, 2008; Chavanne et. al., 2022). Retailers therefore avoid raising prices abruptly for fear of losing customers, particularly in markets where products are close substitutes and switching costs are low. This logic helps explain the near full pass-through of the VAT reduction: lowering prices carries no competitive downside, whereas failing to do so risks immediate reputational and sales losses.

A second mechanism concerns tax salience and institutional oversight. The Office of Competition and Consumer Protection provided institutional oversight by forcing tax salience and monitoring prices (similarly as in Portugal, Bernardino et al., 2025). Moreover, as the government required a clear communication from retailers, which prices changed due to the VAT rate, consumers were better informed. As Chetty et al. (2009) argue, price adjustments are larger and more immediate when taxes are salient—clear, prominent, and easy to observe. Furthermore, the authors provide evidence that when tax changes are not salient, consumer underreact to them, which ultimately results in a inelastic demand curve for inattentive shoppers. Lastly, recent evidence shows that when inflation is high, consumers pay special attention to prices and become attentive (e.g., Pfäuti, 2023, or Weber et al., 2025), thus forcing retailers to answer with an adequate pricing policy. These factors likely contributed to the full pass-through of the VAT reduction.

As regards the incomplete pass-through upon the VAT reversal, we believe that two factors were at play. First, the market remained very price-competitive and large retailers pledged in press that they would not increase prices. This reluctance led to a meagre immediate effect. Moreover, we also uncover that at that time the prices in the manufacturing of food products decreased

considerably (by roughly 7% in April 2024 according to Eurostat). Together with low oil prices, this advantageous development in costs could provide a scope for a smaller immediate price increases without sacrificing mark-ups. This line of argument has been also raised by Bernardino et al. (2025), who claim that deflationary trend in producer prices allowed firms to fully shift the tax decrease onto consumers.

Taken together, these microeconomic mechanisms—competitive pricing pressure, tax salience, consumer attention, loss aversion, customer anger, and input-cost dynamics—provide a coherent explanation for the asymmetric price responses we document. Importantly, they also carry meaningful implications for decision theory, price-setting behaviour, and inflation dynamics.

Our findings provide clear empirical validation for core theories in consumer behaviour. The asymmetric sensitivity to price changes aligns closely with loss aversion, which posits that consumers perceive price increases as disproportionately painful relative to the psychological gain from equally sized price reductions. Because losses loom larger than gains, consumers scrutinize and respond more aggressively to price hikes. This heightened sensitivity is closely linked to customer anger, whereby price increases trigger emotional reactions and punitive behaviour such as switching or complaints. The evidence suggests that retailers anticipate these behavioural responses and therefore treat price increases very differently from price decreases. In this sense, the patterns in our data offer strong support for behavioural models in which consumer loss aversion and anger shape firms' pricing strategies.

Our findings also align well with menu-cost models of price-setting, but they suggest that these models should incorporate psychological menu costs alongside traditional adjustment costs. In standard frameworks, firms change prices only when the benefit outweighs the administrative or technological cost of repricing. Our evidence confirms this logic: the VAT reduction created a large, salient shock that easily cleared this threshold, leading to widespread and immediate adjustments. By contrast, upward adjustments faced an additional barrier. Because consumers are loss-averse and prone to anger when prices rise by much, firms anticipate a higher risk of backlash, which raises the effective cost of increasing prices. These psychological menu costs make firms set a higher threshold for price hikes than for price cuts. Thus, while our findings support the core mechanism of menu-cost models, they also show that real-world pricing frictions reflect not only operational constraints but also the behavioural responses firms expect from their customers.

Finally, our findings are relevant for understanding inflation dynamics. They show that the transmission of cost shocks is asymmetric and depends critically on the structure of the retail sector. Downward cost shocks—such as tax cuts—are passed through rapidly and almost completely, whereas upward shocks—like tax increases—tend to be absorbed or delayed,

particularly by large retailers. This implies that inflation may respond more strongly to deflationary than to inflationary impulses in the short run. In economies where a small number of large retailers dominate the market, such asymmetries can significantly influence the observed path of inflation, underscoring the importance of micro-level retail behaviour for interpreting short-term inflation developments.

4.5. Stylized model

To rationalize the asymmetric pass-through documented in the data, we develop a simple model in which firms face psychological menu costs—additional costs associated with raising prices in the presence of loss-averse and potentially angry consumers.

Environment. Consider a retailer that initially charges price p_0 and faces marginal cost c_0 , with fixed cost set to zero for convenience. A VAT changes marginal cost by Δc , so that:

$$c_1 = c_0 + \Delta c. \quad (17)$$

In response, the retailer chooses a new price:

$$p_1 = p_0 + \Delta p. \quad (18)$$

Demand is downward sloping in the price change:

$$q = q(p_0 + \Delta p) \equiv q(\Delta p), \quad q'(\Delta p) < 0. \quad (19)$$

In addition to any real menu costs (which we set to zero for simplicity), firms face *psychological menu costs* when raising prices.²² These reflect the anticipated behavioural response of consumers—loss aversion, anger, switching, and reputational consequences. Formally, we define the psychological menu costs as:

$$\Phi(\Delta p) = \begin{cases} 0, & \text{if } \Delta p \leq 0, \\ \phi(\Delta p), & \text{if } \Delta p > 0, \end{cases} \quad (20)$$

where $\phi(\Delta p)$ is increasing and convex so that larger price increases generate disproportionately higher psychological costs.

²² Our formulation of psychological menu costs is motivated by Rotemberg (2005), who shows that firms internalise customer anger at price increases, and by empirical evidence that perceived unfair pricing and antagonistic price changes reduce subsequent demand (Anderson and Simester, 2008, 2010). The assumption that consumers react more strongly to price increases than to equivalent price reductions is consistent with models of loss-averse consumers (Heidhues and Kőszegi, 2008).

Retailers differ in their exposure to such behavioural frictions. Let retailer r face the cost:

$$\phi_r(\Delta p) = \lambda_r \phi(\Delta p), \quad (21)$$

where $\lambda_r > 0$ is a firm-specific behavioural sensitivity parameter.

A key assumption—consistent with both theory and the empirical results—is that λ_r is larger for large retailers than for small stores. Large retailers serve millions of customers, operate in highly transparent markets, and rely heavily on reputation. These firms face intense scrutiny from consumers, major competitors, media, and regulators, especially during periods of tax changes or high inflation. Consequently, they internalize greater behavioural costs from price hikes, since even a small increase may trigger customer anger, negative press, or rapid switching. Small retailers, by contrast, have weaker reputational exposure and lower visibility, making the behavioural cost of raising prices smaller. Thus, we assume:

$$\lambda_{r,large} > \lambda_{r,small}. \quad (22)$$

Each firm chooses a price change Δp to maximize the following profit function, which incorporates both standard pricing considerations and psychological menu costs:

$$\max_{\Delta p} \Pi_r(\Delta p) = \pi(\Delta p) - \Phi_r(\Delta p), \quad (23)$$

where static profits after a price change Δp are given by:

$$\pi(\Delta p) = (p_0 + \Delta p - c_1) q(\Delta p). \quad (24)$$

We now consider the implications for VAT reductions and its subsequent reversal. When the VAT rate is reduced, in our framework marginal costs fall ($\Delta c < 0$), so the profit-maximising response typically involves lowering prices, implying $\Delta p < 0$. By construction,

$$\Phi_r(\Delta p) = 0 \quad \text{for } \Delta p \leq 0, \quad (25)$$

meaning that no psychological menu cost is incurred when prices are cut. The firm therefore solves the standard problem:

$$\max_{\Delta p < 0} \pi(\Delta p), \quad (26)$$

and the optimal price decrease may be close to the full mechanical pass-through of the tax cut, depending on demand and supply elasticities. This mechanism can generate the near-complete and immediate pass-through of VAT reductions observed in the data.

In case of a VAT reversal, which raises marginal costs ($\Delta c > 0$), the firm has an incentive to increase its price, implying $\Delta p > 0$. In doing so, however, it incurs a positive psychological menu cost:

$$\Phi_r(\Delta p) = \lambda_r \phi(\Delta p) > 0. \quad (27)$$

The first-order condition for an interior solution with $\Delta p > 0$ is therefore:

$$\Pi_r'(\Delta p) = \pi'(\Delta p) - \lambda_r \phi'(\Delta p) = 0. \quad (28)$$

Relative to the benchmark without psychological menu costs—i.e., when $\lambda_r \phi'(\Delta p) = 0$ —this additional term lowers the optimal price adjustment Δp . Intuitively, the firm chooses a smaller price increase because it internalises the anticipated adverse reaction of consumers, which is captured by the psychological cost term.

We now examine how the optimal response varies across firms. Let Δp_r^* denote the optimal price change of retailer r . Under standard regularity conditions, the optimal Δp_r^* is decreasing in λ_r :

$$\frac{\partial \Delta p_r^*}{\partial \lambda_r} < 0. \quad (29)$$

Economically, this means that retailers with higher psychological menu costs—such as large, reputation-sensitive firms or market leaders—choose smaller price increases in response to the same VAT shock. Conversely, retailers with lower λ_r (e.g., small retailers) increase prices by more, implying higher immediate pass-through.

The model yields three qualitative implications that are consistent with the empirical patterns. First, because price reductions do not generate psychological menu costs, VAT cuts are passed through rapidly and can be close to complete. Second, VAT hikes trigger psychological menu costs, which raise the effective threshold for increasing prices; as a result, price increases occur immediately but the overall pass-through is incomplete. Third, the model predicts systematic heterogeneity across retailers: large retailers—especially market leaders with high λ_r —raise prices by less in response to a VAT hike than smaller retailers, generating cross-sectional differences in pass-through consistent with our empirical findings.

Importantly, these implications are intended to provide an illustrative interpretation of the observed asymmetries, rather than to uniquely identify the underlying mechanism in the data.

5. Conclusion and discussion

This paper investigates whether prices respond asymmetrically and heterogeneously across retailers to identical VAT shocks, but of opposite sign. The temporary reduction of the VAT rate on basic food products from 5% to 0% and its subsequent reversal back to 5% create a natural setting for this study. Using a rich combination of micro-level CPI data and high-frequency web-scraped prices, we analyse how price-setting behaviour changed around these two large and sudden tax interventions. Our findings reveal several robust and economically meaningful patterns.

First, the VAT reduction generated an immediate and near-complete pass-through. Both monthly and daily data show a sharp spike in the frequency of price decreases exactly at the moment the lower rate took effect, with no comparable response among untreated products. The size of individual price adjustments changed little, indicating that the VAT reduction worked primarily by triggering widespread repricing rather than by altering the magnitude of typical price changes. These results reject the interpretation that retailers passed through the tax cut only gradually over several months. As such, this anti-inflationary measure proved to be a fast and effective tool lowering the price level of basic foodstuff.

Second, the response to the VAT reversal was markedly different. Although prices again reacted immediately, the pass-through was incomplete, and the frequency of price increases displayed substantial persistence in the months that followed. Importantly, this asymmetry was driven not by all retailers but by strong heterogeneity across them. Small retailers increased prices quickly, some even by more than the mechanical VAT effect, whereas large retailers raised prices only partially and, in some cases, delayed the adjustment for many weeks. This divergence is consistent with public commitments made by several large chains as well as with the highly competitive nature of the Polish food retail sector.

Third, the fixed-effects panel analysis confirms these patterns formally. Small and large retailers behave similarly in response to the VAT reduction, but their reactions diverge sharply during the reversal. Large retailers transmit the VAT increase significantly less than the VAT reduction, while small retailers respond symmetrically to both shocks. Equality tests reject symmetry within large retailers but not within small ones, reinforcing the conclusion that the asymmetry is driven by differences in retailer size and strategic incentives.

Fourth, our findings highlight the value of high-frequency online price data for analysing policy shocks. We show that such data provide richer information, sharpen identification and allow for a cleaner measurement of both the timing of price responses and their distribution across retailers.

In particular, high-frequency prices help avoid biases related to temporal aggregation and market structure, which tend to average out shocks over the month and across retailers, thereby downplaying the significance of one-off events. In our case, monthly data suggest that the response of retailers to VAT reversal was gradual. By contrast, daily data reveal a markedly different adjustment pattern: price changes were postponed only by large retailers and, when they occurred, took place in a sequence of discrete jumps rather than as a gradual process unfolding over time. These findings contribute to a growing literature demonstrating the usefulness of online prices for studying price formation—see Lünemann and Winttr (2011), Gorodnichenko and Talavera (2017), Gorodnichenko et al. (2018), Cavallo (2018), Henkel et al. (2023) and Strasser et al. (2023). As e-commerce becomes increasingly prevalent (Mućk et al., 2025), online prices offer a valuable window into firms’ behaviour in response to exceptional shocks.

Fifth, the asymmetric response we document has clear microeconomic underpinnings. In a highly competitive market, retailers appear far more willing to pass through tax cuts than tax increases. The evidence suggests that firms—especially large chains—are reluctant to raise prices abruptly due to fears of consumer backlash, reputational damage, and the risk of losing market share. This aligns with recent research highlighting “consumer anger” (Stelmasiak et al., 2024) and with empirical evidence showing that perceived unfair pricing and antagonistic price changes reduce subsequent demand (Anderson and Simester, 2008, 2010) and offers a behavioural explanation for why price increases are treated differently from price reductions.

Finally, we propose a stylised conceptual framework featuring psychological menu costs to rationalise these findings. In the optics of our model, price reductions generate no behavioural penalties and hence are passed through rapidly, whereas price increases trigger consumer loss aversion and anger, raising the effective cost of repricing. We argue that larger, reputation-sensitive retailers operating under greater public scrutiny internalise these psychological menu costs more strongly and therefore raise prices by less than smaller retailers. This behavioural mechanism is consistent with our key empirical evidence of near-complete pass-through of VAT cuts, incomplete pass-through of VAT increases, and systematic cross-sectional heterogeneity.

Overall, our results underscore that the incidence of tax changes in competitive retail markets depends not only on cost shocks and market structure but also on behavioural forces shaping firms’ pricing decisions. Understanding these mechanisms is essential for interpreting short-term inflation developments and for designing effective temporary tax interventions.

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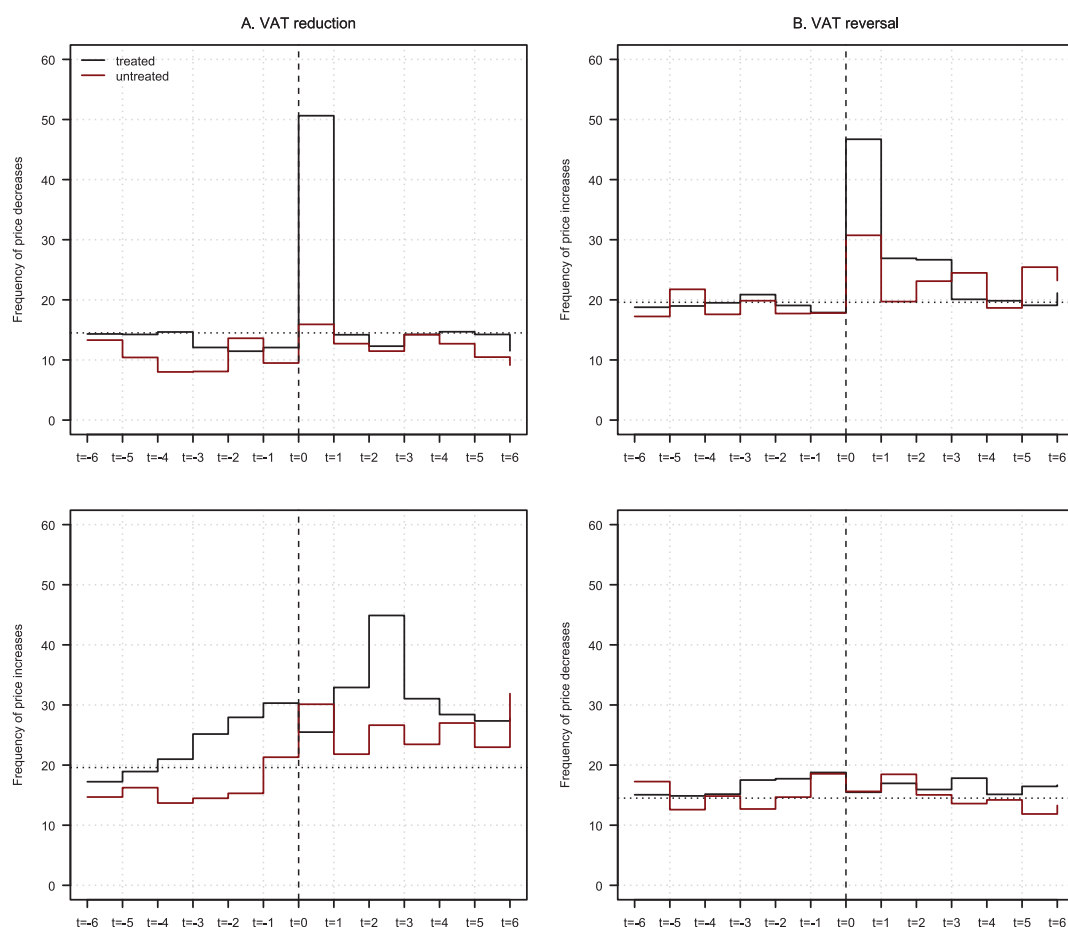
Tables and figures

Table 1 Fixed-effects panel regression results

	coefficient	robust standard error	t statistic	p value	95% confidence bands
$D^S \times V^-$	-1.129***	0.103	-10.930	0.000	[-1.332, -0.927]
$D^L \times V^-$	-1.308***	0.170	-7.680	0.000	[-1.641, -0.974]
$D^S \times V^+$	1.447***	0.173	8.364	0.000	[1.108, 1.786]
$D^L \times V^+$	0.450*	0.264	1.706	0.088	[-0.067, 0.966]
D_1	0.311***	0.081	3.827	0.000	[0.151, 0.470]
D_2	0.044	0.102	0.429	0.668	[-0.157, 0.244]
D_3	0.039	0.084	0.468	0.640	[-0.125, 0.204]
D_4	-0.015	0.079	-0.190	0.849	[-0.170, 0.140]
e	0.045**	0.020	2.212	0.027	[0.005, 0.085]
n	12				
T	139-1038				
N	8818				
$F(9,11)$	111.863***				
Outcomes of the test $\beta_1 = \beta_2$			Outcomes of the test $\beta_3 = \beta_4$		
$F(1,11)$	0.87		$F(1,11)$	9.99***	
p	0.350		p	0.002	
Outcomes of the test $ \beta_1 = \beta_3 $			Outcomes of the test $ \beta_2 = \beta_4 $		
$F(1,11)$	2.81*		$F(1,11)$	5.97**	
p	0.093		p	0.015	

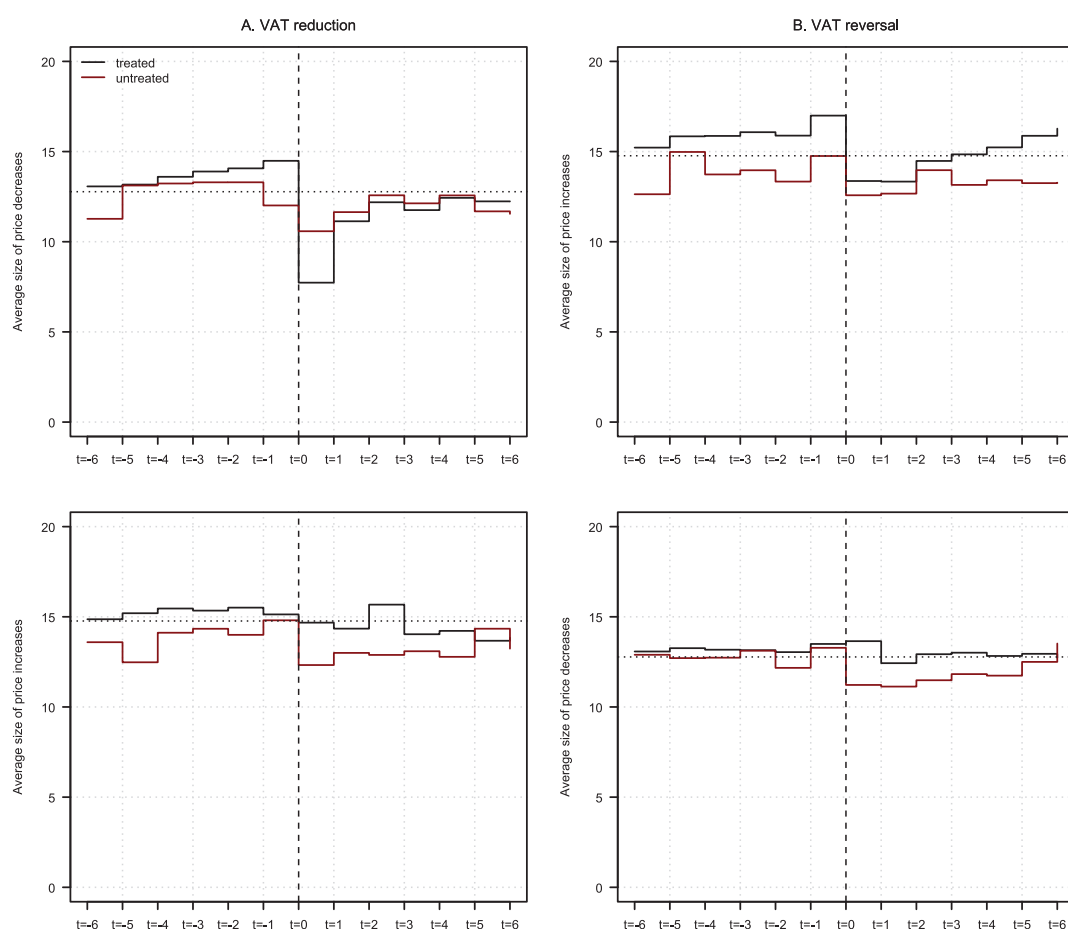
Note: the table summarizes estimation results for the model specified in equation (1). ***, ** and * denote significance at 1%, 5% and 10%, levels respectively. Significance is based on cluster-robust standard errors. The sample covers period 2021-2024.

Figure 1 Frequency of price increases and decreases around the VAT rate changes on basic food products



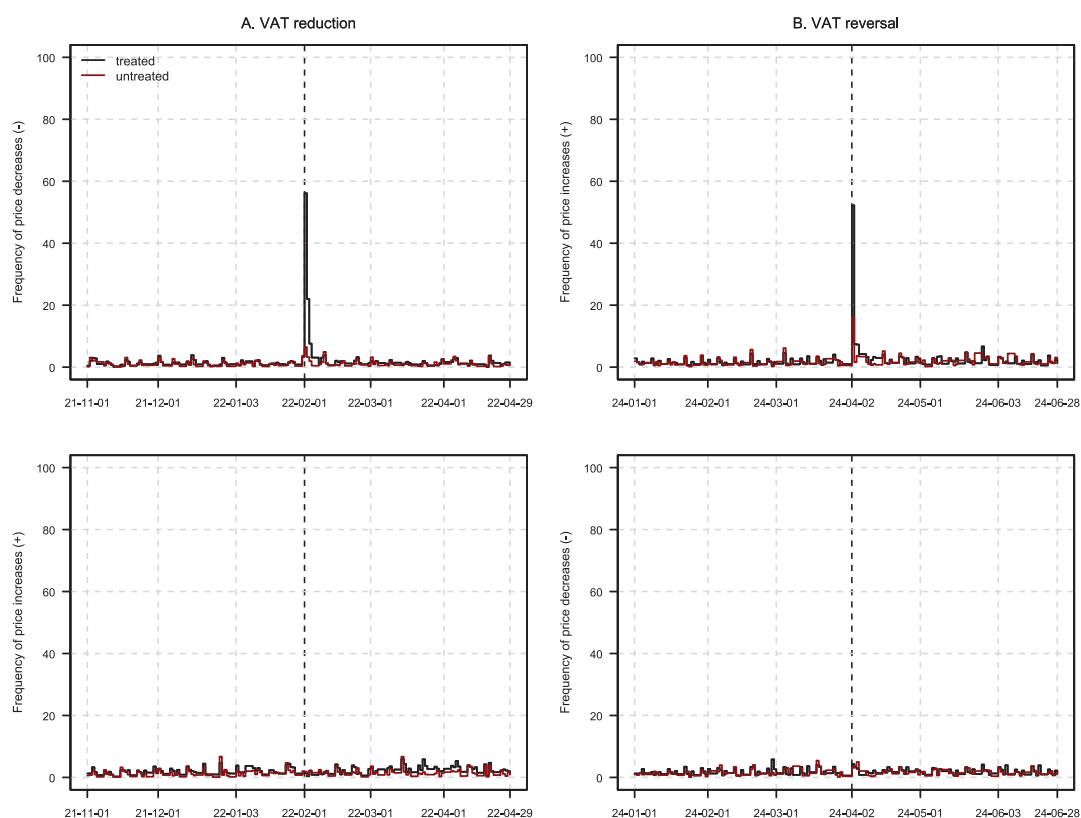
Note: the figure presents the seasonally adjusted frequencies of price increases and decreases for the treated (black line) and untreated (red line) product groups around the reduction of the VAT rate on basic food products from 5% to 0% on February 1st, 2022, and the reinstatement of the VAT rate on basic food products to 5% on April 1st, 2024. These metrics are computed from monthly unit-price dataset. The vertical dashed black line indicates the day of the VAT rate change, while the horizontal dashed line shows the sample mean for the treated product groups.

Figure 2 Size of price increases and decreases around the VAT rate changes on basic food products



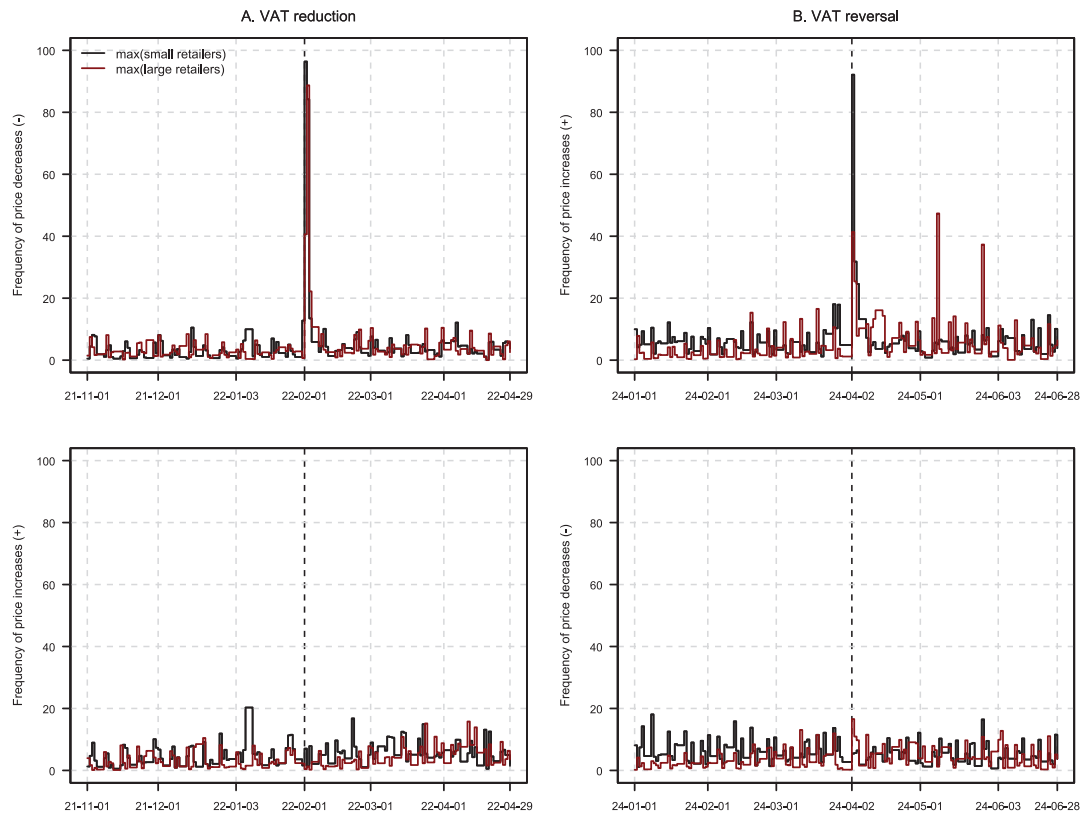
Note: the figure presents the seasonally adjusted size of price increases and decreases for the treated (black line) and untreated (red line) product groups around the reduction of the VAT rate on basic food products from 5% to 0% on February 1st, 2022, and the reinstatement of the VAT rate on basic food products to 5% on April 1st, 2024. These metrics are computed from monthly unit-price dataset. The vertical dashed black line indicates the day of the VAT rate change, while the horizontal dashed line shows the sample mean for the treated product groups.

Figure 3 The pricing policy around the VAT rate changes on food products (aggregate across retailers)



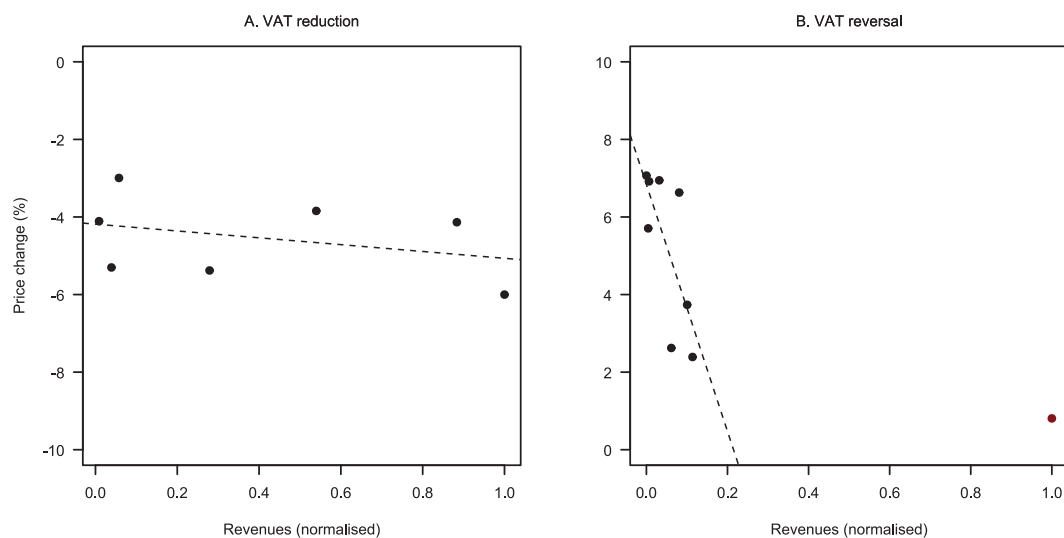
Note: the figure presents the frequencies of price increases and decreases for the treated (black line) and untreated (red line) product groups around the reduction of the VAT rate on basic food products from 5% to 0% on February 1st, 2022, and the reinstatement of the VAT rate on basic food products to 5% on April 1st, 2024. These metrics are calculated as unweighted aggregate of all retailers in the high-frequency dataset. The dashed black line indicates the day of the VAT rate change.

Figure 4 The pricing policy of small and large retailers around the VAT rate changes on food products



Note: the figure presents the frequencies of price increases and decreases across small (black line) and large retailers (red line) for the treated product groups around the reduction of the VAT rate on basic food products from 5% to 0% on February 1st, 2022, and the reinstatement of the VAT rate on basic food products to 5% on April 1st, 2024. At each point in time, the maximum value of the respective metric within each retailer group is reported. These metrics are computed using the high-frequency dataset. The dashed black line marks the day of the VAT rate change.

Figure 5 Immediate change in the average price level following the VAT rate changes by retailers



Note: the figure shows the average price change (in %) for the treated product group during the first 5 days following the VAT reduction and its reversal for all retailers in the sample. VAT reduction refers to the VAT rate cut on basic food products from 5% to 0% on February 1st, 2022. VAT reversal refers to the reinstatement of the VAT rate on basic food products at 5% on April 1st, 2024. Results are based on the seasonally adjusted daily price index, with day of week effects removed. Dashed lines indicate a simple regression relating the price change to the level of revenues. Annual revenues of the retailers are compiled from press data and normalised to [0,1] range within each respective sample. Data for the largest retailer in our sample are unavailable for the VAT reduction episode, as this retailer did not begin posting prices online prior to 2024.

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