NBS Working paper
7/2025

From VAT Cuts to Price Tags: Evidence from Scanner Data

Brian Fabo, Pavel Gertler, Peter Toth

NATIONAL BANK OF SLOVAKIA
EUROSYSTEM

www.nbs.sk

research@nbs.sk

This publication is available on the NBS website
www.nbs.sk/en/publications-issued-by-the-nbs/research-publications

ISSN 2585-9269 (online)

From VAT Cuts to Price Tags: Evidence from Scanner Data *

Brian Fabo† Pavel Gertler ‡ Peter Tóth §

July 18, 2025

Abstract

This paper examines how consumer prices responded to two permanent VAT reductions in Slovakia, which lowered the rate from 20% to 10%, first for essential staples in 2016, and later for a broader set of goods in 2020. Leveraging detailed scanner data and a synthetic difference-in-differences framework, we find that VAT pass-through is highly heterogeneous: it can be full or incomplete, depending on product attributes, demand elasticity, and policy design. The 2016 reform, which targeted clearly defined essential goods, led to complete and persistent price reductions. In contrast, the 2020 reform, applied to a loosely defined category of healthy goods, produced only partial and short-lived price effects. Our findings underscore the importance of careful policy design, and suggest that well-targeted VAT cuts can deliver meaningful consumer price relief, while broader or less transparent interventions may instead boost retailer margins without durable benefits for shoppers.

Keywords: VAT pass-through, consumption tax reform, tax incidence, scanner data.
JEL Classification: D12, E62, H22, H25, H31

*The views and results presented in this paper are those of the authors and do not necessarily represent the official opinion of the National Bank of Slovakia. The authors thank Phillip Lane, the participants at the 29th International Conference on Macroeconomic Analysis and International Finance at Rethymno, Greece and the anonymous NBS WP series reviewer for useful comments received at various stages of preparation of this article.

†National Bank of Slovakia; Institute for Forecasting, Slovak Academy of Sciences
‡National Bank of Slovakia
§National Bank of Slovakia, University of Economics in Bratislava

1 Introduction

Value-added tax (VAT) is the largest part of the government revenue in many countries. As its rate is easy to adjust, it is often the focal point in policy discussion. Reductions in VAT may be considered to ease the burden on consumers during periods of high inflation or to stimulate the economy. Conversely, increasing VAT can serve as a means of boosting government revenues. In either case, changes in VAT rates have significant economic implications. From an efficiency perspective, the key concern is the extent to which these changes are passed through to consumer prices.

Previous research highlights that the pass-through of VAT to prices is not necessarily complete and is often asymmetric, with downward adjustments proving less effective than upward adjustments in altering consumer prices (e.g. Benzarti, 2024; Carbonnier, 2005). In simple terms, raising indirect taxes leads to higher prices, but lowering them often leads to greater profits (Benzarti et al., 2020). The degree to which VAT cuts pass through to prices depends on several interrelated factors, including the elasticity of supply and demand, market structure, and the characteristics of the affected products. Products with price inelastic demand often show higher VAT pass-through, while those with elastic demand, like luxury goods, may see producers absorbing more of the tax (Harberger, 1962). Other factors, including market competition and practical considerations, such as warehousing and menu costs, may further influence pass-through.

The evidence of a complete pass-through of upward VAT adjustments has been fairly well documented Benedek et al. (2020). However, analyzing the pass-through of downward tax adjustments presents greater challenges, primarily due to data limitations in precisely identifying relevant products over time. Upward tax adjustments are typically applied across the board as part of fiscal consolidation efforts, whereas downward adjustments often target specific groups of products and services to address social or economic objectives, necessitating the analysis of unique product prices.

Our study of the effect of VAT cuts contributes to the literature in two ways. First, due to a unique sequence of policy changes in Slovakia, we are able to compare two instances of VAT cuts implemented within a relatively short time frame. Both cuts were communicated as permanent[1], and equal in the size of the rate reduction, but they differed significantly in their design. Second, unlike many studies that rely on aggregated data, our analysis is based on granular scanner data from a leading supermarket chain, providing individual product-level information on prices and the corresponding VAT rates.

Prior to 2016, Slovakia applied a standard VAT rate of 20% and a reduced rate of 10% on books and medicines. In 2016, the reduced 10% VAT rate was extended to basic food items such as bread, butter, milk, meat, and fish. A subsequent policy change in 2020 broadened the scope of the lower rate to include a much wider range of "healthy, domestically produced" goods, well beyond basic necessities, including also non-foods such as healthcare

[1]No clause stipulating an end date for this measure was included in the legislation, and there has been no discussion regarding its temporary nature.

products, child diapers, and selected newspapers based on their content.[2] Unlike the 2016 VAT reform, the reduction did not apply to entire product categories. Instead, the selection of items was specifically determined by the Ministry of Agriculture.[3]. Table A1 in Appendix A contains a detailed overview of goods affected.

Employing the synthetic difference-in-differences approach of Arkhangelsky et al. (2021), with non-food grocery products serving as the control group, we find that the effect of VAT reductions on consumer prices depends markedly on the design of the policy. Specifically, we observe full pass-through of the 2016 VAT cut, whereas in 2020, only about two-thirds of the tax reduction was reflected in lower prices for consumers. The extent of pass-through also varies considerably across product categories and pricing strategies. These results suggest that a targeted VAT reduction on basic necessities can yield a lasting—and in our case, complete—price effect. In contrast, broadening the reduced rate to include a loosely defined set of *healthy* products appears to produce only a temporary signaling effect, with price impacts dissipating within a few weeks. Our findings are consistent with theoretical predictions: VAT pass-through tends to be higher for essential goods and for products with standardized units and packaging, where prices are more transparent and easily comparable.

The remainder of this paper is organized as follows. Section 2 reviews additional findings from the literature. Section 3 outlines the methodology and data. Section 4 presents the results and relates them to economic theory. In Section 5, we discuss our findings in the context of household distributional characteristics. Finally, Section 6 concludes.

2 Related literature

The extent and dynamics of VAT pass-through depend on several key factors, which we review here. The foundational principle, rooted in public finance theory, is that the ultimate economic burden of a tax is determined by the relative price elasticities of supply and demand. In a seminal contribution, Harberger (1962) used a two-sector general equilibrium model to show how a tax levied on capital in one sector could be shifted throughout the economy, with the final incidence depending on factor substitution and demand elasticities. While our focus is a consumption tax, Harberger's framework underscores the importance of a systemic view. Generally, a greater share of a tax cut is passed to consumers when demand is inelastic and supply is elastic (Ramsey, 1927). This explains why necessities, which have inelastic demand, tend to exhibit higher pass-through than luxury goods.

Beyond these core elasticities, market structure is another critical determinant of pass-through. Competitive markets, where firms operate with low markups, typically exhibit higher pass-through rates (Bellon & Copestake, 2022; Benzarti et al., 2020; Blundell, 2009). In contrast,

[2] Legislative changes of the 2016 cut were adopted in July 2015 and came into effect in January 2016 and those of 2020 VAT cut were adopted in October 2019, and came into effect in January 2020.

[3] The difference in scope between the two reforms was also reflected in their fiscal cost. According to estimates from the Council for Budget Responsibility of Slovakia, the broader 2020 VAT reduction had an estimated annual fiscal cost of €400 million. In contrast, the more targeted 2016 reduction on basic staples had an estimated cost of €77 million (approximately €84 million in 2020 terms).

firms in monopolistic or oligopolistic markets may use their pricing power to absorb VAT decreases into their margins. An example of this has been shown by Dimitrakopoulou et al. (2024), who examined the Greek islands as isolated oligopolistic markets and found pass-through rates of just 50%, compared to around 80% in more competitive markets. The characteristics of the products themselves also play a significant role. Product differentiation, for instance, can reduce demand elasticity and allow firms with strong brand loyalty to pass on VAT changes more effectively (Tirole, 1988). Furthermore, tax changes can have spillover effects; studies such as Besley and Rosen (1999) highlight that changes in the tax on one product may also affect the pricing of its complements.

Empirical literature often finds that the pass-through is incomplete. Nakamura and Steinsson (2008), for instance, emphasize that even small menu costs can create significant price rigidity. This is supported by empirical evidence from European firms, where menu costs are found to contribute significantly to infrequent price changes (Vermeulen & Gábor, 2014). Other practical factors, such as warehousing costs, can also create asymmetries; retailers may delay passing on VAT reductions until pre-taxed inventory is cleared, whereas VAT hikes often lead to immediate price increases (as e.g. in Benedek et al., 2020).

The design and communication of the policy itself are also crucial. The duration of the tax change matters, though the evidence is mixed. Some studies find that permanent VAT changes produce higher pass-through than temporary ones (Benzarti et al., 2024; De Amores et al., 2023) and that the price effects of temporary cuts tend to dissipate quickly (Crossley et al., 2014). In contrast, Bernardino et al. (2025) study a temporary VAT cut in Portugal and find that it was fully and persistently transmitted to consumer prices, suggesting that the policy context and salience are key mediating factors. Finally, with the share of online shopping steadily increasing (ECB, 2022), it is important to note that online prices exhibit different dynamics. As documented by Gorodnichenko et al. (2018), lower menu costs in online markets lead to more frequent, but less synchronized, price adjustments. While this is a growing area of interest, our analysis does not focus on the online segment.

Our research contributes to a specific gap in the literature. While the pass-through of upward VAT adjustments is well-documented[4], evidence on downward adjustments at a highly granular level remains limited. Notable exceptions include Buettner and Madzharova (2021), who examine prices of domestic appliances across the EU, Buettner et al. (2023), who study the narrower segment of feminine hygiene products in Germany, and Bernardino et al. (2025) who analyze a temporary VAT cut in Portugal using product-level data from online supermarkets. Our research seeks to add to this field by analyzing scanner data from two distinct VAT cuts in Slovakia (2016 and 2020) covering a large variety of food products, where consumer behavior, market structure, and product characteristics interact in heterogeneous ways.

[4]See e.g. Hindriks and Serse (2019), who estimate the pass-through of an excise tax hike to spirit retail prices in Belgium.

3 Data and methodology

3.1 From elasticities to pass-through

Following a similar notation as in Benedek et al. (2020), suppose the consumer price p_i of a commodity bundle i is composed of a producer price $\tilde{p}_i$ and an ad-valorem tax rate τ_i given by $p_i := \tilde{p}_i(1 + \tau_i)$. Let us define the pass-through of a hypothetical tax change $\Delta\tau_i$ to the consumer price p_i as:

$$\gamma_i := \frac{\frac{\Delta p_i}{p_i}}{\frac{\Delta \tau_i}{1+\tau_i}} \tag{1}$$

If the producer price remains constant following the tax change, then $\gamma_i = 1$ and there is a complete pass-through. In other cases, overshifting ($\gamma_i > 1$) or undershifting ($\gamma_i < 1$) occurs. In the textbook example of Benedek et al. (2020), γ_i is a function of the price elasticities of supply and demand. In the most basic case, γ_i is determined by the own-price elasticity of supply ϵ_s^{ii} and the uncompensated own-price elasticity of demand ϵ_d^{ii}:

$$\gamma_1 = \frac{\epsilon_s^{ii}}{\epsilon_s^{ii} - \epsilon_d^{ii}} \tag{2}$$

The above formula implies that a higher demand elasticity $|\epsilon_d^{ii}|$, with more price-sensitive consumers, lowers the pass-through of a tax change. Whereas the supply elasticity works in the opposite direction, so that a higher ϵ_s^{ii} implies higher pass-through. Put differently and considering a tax cut, as in our empirical application, the balance between the two elasticities determines the share of the tax reduction enjoyed by consumers (through lower prices) versus retailers (through retained margins).

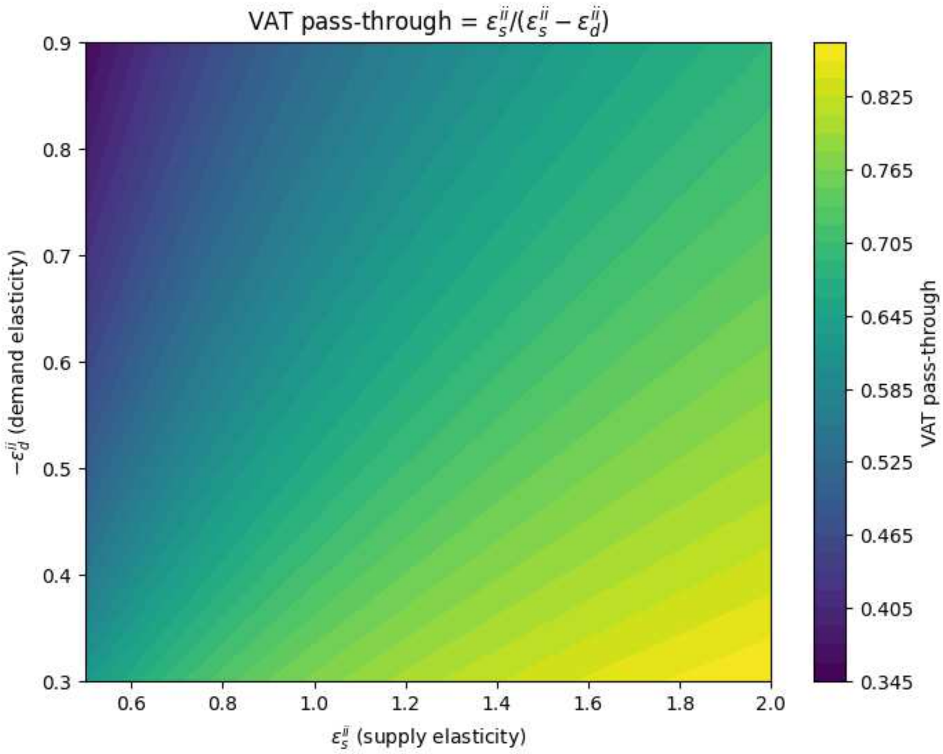
With a simple extension including cross-price effects, i.e. allowing for the presence of substitutes or complements in another commodity bundle, j, the pass-through formula becomes:

$$\gamma_i = \frac{\epsilon_s^{ii}}{\epsilon_s^{ii} + \epsilon_d^{ii} - \left(\frac{\epsilon_d^{ij}\epsilon_d^{ji}}{\epsilon_s^{jj} - \epsilon_d^{jj}}\right)} \tag{3}$$

where ϵ_d^{ij} and ϵ_d^{ji} are cross-price elasticities of demand, and ϵ_s^{jj} is the own-price elasticity of supply of bundle j. Note that the new term in the denominator, $\epsilon_d^{ij}\epsilon_d^{ji}/(\epsilon_s^{jj} - \epsilon_d^{jj})$, is positive given that ϵ_d^{ij} and ϵ_d^{ji} have the same sign and ϵ_d^{jj} is negative. Therefore the new term with a negative sign in front of the parenthesis will increase the pass-through rate for bundle i (see Benedek et al., 2020).

To sum up, the pass-through of VAT changes to consumer prices is a complex outcome influenced by market structure, product characteristics, and consumer preferences. Elasticities of supply and demand, including both own and cross-price elasticities, are crucial for determining how much of a tax change is reflected in final prices. To infer the expected range of pass-through rates, we plugged realistic elasticity figures into (2) and (3). First, we assumed a broad interval of supply elasticities from 0.5 to 2, where the lower bound approximates the short-run, and the upper bound reaches long-run values. Next, we used own-price elasticities of demand ranging from 0.3 to 0.9, based on an empirical study for Slovakia (Tóth et al., 2021, Table B.4, Appendix B), a range that is also typical for food products in other empirical studies. The above range of elasticities yields an interval for the expected pass-through from 0.4 to 0.8 (see Figure 1 below). The lower bound for pass-through results from a combination of high demand elasticity (i.e. more luxurious foods) and low supply elasticity (e.g. fresh foods), while the upper bound results from a low demand elasticity (e.g. essential foods) and a high supply elasticity (e.g. non-perishables, imported products, or private labels[5] with plenty of stocks). Adding cross-price elasticities in the picture based on (3) does not significantly alter the range of implied pass-through rates.[6]

Figure 1: The expected range of pass-through rates based on price elasticities



Source: own calculations.

3.2 Data

We use scanner data from a leading supermarket chain in Slovakia, covering transactions between June 2015 and February 2020. We use weekly averages of individual prices for each product scanned and sold at any point-of-sale in retail stores across the country. Apart from prices, the data contains a timestamp and relevant attributes of the store where each transaction occurred. Prices are recorded in two variables: the standard or base price of the item, and the discounted price, which reflects the actual price paid by the customer. In about 60% of the cases, the discounted price is lower than the standard price, while in the

[5]Under private label products we understand goods that are manufactured by a third party but sold under a retailer's own brand name. They are typically offered as more affordable alternatives to national brands and are commonly found in grocery chains, where the retailer controls the branding, pricing, and marketing.

[6]We used typical values, such as $\epsilon_d^{12} = -0.2$ for substitutes, following the estimates of Tóth et al. (2021).

remaining cases, the two values are equal. Although the dataset does not specify the reasons for discounts, they typically include one or more of the following: chain-wide promotional discount, store manager assigned discounts or discounts applied to customers holding the loyalty card. Although we do not have direct information on quantities sold, we can approximate demand by observing changes in the frequency of purchases at the product level.

Given that the effective date of the policy change was Thursday, 2 January 2020 (with all stores nationwide closed on 1 January), and that the pricing strategy of this chain follows a weekly discount cycle from Wednesday to Tuesday, this setup provides an ideal framework for analyzing the weekly dynamics of pass-through to prices. In 2016, however, the New Year holiday split the week across two calendar years. To test the robustness of our estimates, we also implemented an alternative specification using the prior week, which yielded only marginal differences in the results.

Additionally, the chain provides detailed information on any changes in the VAT rate for each item. This allowed us to accurately identify the specific products affected by the policy change. Table 1 presents descriptive statistics illustrating price data following the 2016 and 2020 VAT cuts.

To estimate the effect of the VAT reduction (treatment), we track the dynamics of prices and purchase frequencies for products subject to the VAT change (treated units), and compare them to products with unchanged VAT rates (control units). For each of the studied reforms, implemented in 2016 and 2020 respectively, we observe products for eight weeks after the policy change. In the case of the 2020 reform, the eight-weeks follow-up period is designed to avoid data contamination from the lockdown policies introduced in response to the Covid-19 pandemics, beginning in March 2020, which had a significant effect on prices (ECB, 2023). For the 2016 reform, we apply the same length of post-treatment period to ensure comparability of estimation results with the 2020 reform. Due to data availability starting from July 2015, the pre-treatment period for the 2016 reform is limited to 27 weeks. For the 2020 reform, we include the entire pre-treatment year, i.e. 52 weeks of data in our estimation. As our methodology requires a balanced panel, we did not include additional pre-treatment years for the 2020 reform, as doing so would reduce the number of products observable throughout the whole estimation period.

3.3 Empirical Framework

Our empirical strategy to estimate the pass-through rate above is based on a standard difference-in-differences (DID) setup with two-way fixed effects of the following form:

$$\ln y_{i,t} = \alpha T_{i,t} + \theta_i + \delta_t + \epsilon_{i,t}, \tag{4}$$

where the dependent variable $y_{i,t}$ is the logarithm of prices or purchase frequencies, i indexes products sold and t refers to time in weeks, $T_{i,t}$ is the treatment indicator taking the value $T = 1$ if i is a product subject to the VAT reclassification and $t \geq 2020W1$ (or $t \geq 2016W1$ in case of the earlier reform), and $T = 0$ for other products and in the pre-treatment time periods. The equation above includes fixed effects for products (θ_i) and time periods (δ_t), while

Table 1: Descriptive Statistics

Year	Category (Breakdown)	N (products)	Mean Price (€)	Std. Dev. Price (€)
2020	**Treated Foods**	**472**	**1.13**	**1.14**
	Foreign	220	1.26	1.11
	Domestic	204	1.09	1.24
	Non-Private Label	318	1.11	1.21
	Private Label	154	1.17	0.99
	Bakery	14	0.23	0.32
	Dairy	241	0.62	0.57
	Vegetables	66	1.64	1.09
	Fruits	49	2.56	2.00
	Juices	87	1.54	0.80
	Untreated Non-Food Groceries	**1,705**	**3.48**	**2.91**
	Foreign	1,593	3.59	2.97
	Domestic	38	1.58	0.97
	Non-Private Label	1,565	3.65	2.96
	Private Label	140	1.59	1.00
2016	**Treated Foods**	**284**	**1.04**	**0.90**
	Foreign	17	3.63	2.26
	Domestic	223	0.84	0.31
	Non-Private Label	183	0.87	0.44
	Private Label	101	1.34	1.34
	Bakery	256	0.87	0.30
	Dairy	12	0.86	0.20
	Meat	16	3.91	2.10
	Untreated Non-Food Groceries	**2,255**	**3.05**	**2.48**
	Foreign	2,082	3.14	2.54
	Domestic	73	1.57	1.02
	Non-Private Label	2,098	3.16	2.51
	Private Label	157	1.50	1.21

Note: Data refer to balanced panels of products available in weeks 2015w26-2016w8 and 2019w1-2020w8, respectively. Fish are merged into the ”Meat” category and jams are merged into the ”Fruits” category. Descriptive statistics for Untreated Foods can be found in Appendix Table A3.

$\epsilon_{i,t}$ is an i.i.d. error term. The main estimate of interest is coefficient α, which represents the average treatment effect on the treated (ATT), i.e. the percentage change in prices or purchase frequencies due to the policy intervention. We apply the above empirical approach for the two reforms separately, as well as to different subsamples of the data according to product types. This allows us to explore the heterogeneity of ATT estimates. Finally, the implied pass-through rate of the studied VAT cuts from 20% to 10% based on the ATT is $\gamma = \alpha 1.2/(-0.1)$, following (1).

In our application, we use a recent enhancement of the standard DID model. Arkhangelsky et al. (2021) introduced[7] the Synthetic Difference-in-Differences (SDID) estimator, which incorporates elements of the Synthetic Control Method (SCM) developed by Abadie et al.

[7] A practical software implementation in Stata is available by Clarke et al. (2024).

(2010) to address limitations inherent in the parallel trends assumption on the standard DID approach. SDID allows for treated and control units to differ in both levels and trends prior to treatment, improving robustness to deviations from the standard DID framework. Unlike DID, which assumes that all units would have followed the same path in the absence of treatment, SDID constructs optimally weighted synthetic control units that closely mirror the pre-treatment trajectory of the treated units as parallel trends. This is achieved by solving a weighted least squares problem where unit and time weights are optimally selected to minimize the discrepancies in pre-treatment trends, subject to regularization. Furthermore, SDID relaxes the identification requirement of SCM that the treated unit's pre-treatment characteristics must lie within the convex hull of the control units' characteristics. This means the exact matching of pre-treatment trends, which SDID does not require for identification. As a result, SDID balances the strengths of DID and SCM, offering improved identification of causal effects in settings where the parallel trends assumption is likely to be violated.

While equation (4) allows to estimate the static, or overall pass-through, the SDID setup can be adapted to study the post-treatment dynamics of the treatment effect[8] in an event study fashion, following the approach suggested in Clarke et al. (2024):

$$\left(\bar{Y}_t^{Tr} - \bar{Y}_t^{Co}\right) - \left(\bar{Y}_{baseline}^{Tr} - \bar{Y}_{baseline}^{Co}\right) \tag{5}$$

where $\bar{Y}_t^{Tr,Co}$ are the means of $\ln y_{i,t}$ conditional on post-treatment status (Tr for treated and Co for control), averaged in time period t, while $\bar{Y}_{baseline}^{Tr,Co}$ refer to baseline (pre-treatment) means conditional on post-treatment status (Tr or Co). In standard panel event studies it is common to assume a baseline period before treatment, for which the baseline means above are computed. In case of SDID, where pre-treatment weights $\hat{\lambda}_t^{\text{SDID}}$ are estimated, the baseline means can be determined as:

$$\bar{Y}_{\text{baseline}}^{\text{Tr}} = \sum_{t=1}^{T^{\text{pre}}} \hat{\lambda}_t^{\text{SDID}} \, \bar{Y}_t^{\text{Tr}} \qquad \bar{Y}_{\text{baseline}}^{\text{Co}} = \sum_{t=1}^{T^{\text{pre}}} \hat{\lambda}_t^{\text{SDID}} \, \bar{Y}_t^{\text{Co}} \tag{6}$$

where T^{pre} denotes the end of the pre-treatment period.

3.4 Control Group Design

To ensure credible identification of VAT pass-through effects, we design our control group to match treated products based on pre-policy price dynamics. This is crucial for attributing post-treatment price changes specifically to the VAT intervention rather than to unrelated trends or structural pricing differences. Several studies in the VAT pass-through literature highlight heterogeneity in pass-through rates driven by product characteristics, retailer behavior, and market structure, i.e. factors that motivate a careful construction of comparable treated and control items.

[8] Due to the mentioned limitations by the outbreak of the Covid-19 pandemics starting from March 2020, we estimate the dynamics up to eight post-treatment weeks for the 2020 VAT cut, and for comparability of results also for the 2016 VAT cut.

For example, Mayler (2014) finds that pass-through differs significantly between branded and private-label products, and is generally lower for price leaders. Similarly, Benzarti et al. (2023) document large differences in pass-through between large chains and isolated retailers. These patterns suggest that failure to account for such heterogeneity can lead to biased estimates if control items differ systematically from treated ones in terms of their market position or pricing strategy.

More importantly, Kampouris (2023) and Fuest et al. (2024) demonstrate that the degree and speed of VAT pass-through is shaped by local market competition and pricing norms, again reinforcing the need to compare products that follow similar price-setting behavior before the policy change. Without such comparability, estimated pass-through rates risk being distorted by retailer or market-specific pricing patterns rather than capturing the true effect of the VAT change.

We therefore construct our control group using two complementary strategies. First, we identify untreated food items with pre-treatment price patterns similar to those of treated items. This enables within-category comparisons, where factors like supply chains, seasonality, and demand are likely aligned. Second, we use selected small non-food grocery (NFG) products that are unaffected by food-related VAT changes, but in general could mimic food consumption patterns. The NFG control group includes non-durables serving everyday consumption of adults, including product categories with gender-specific variants, but not consumed exclusively by any of the genders, such as soaps, shower gels, air fresheners, detergents (for dishwashing, toilet cleaning, and laundry), deodorants, shampoos, hair styling products, household papers (towels, tissues, napkins, and toilet papers), toothpastes and mouthwashes, vitamins, and shaving products (creams, foams, gels). By focusing on products with similar price histories and accounting for potential cross-product substitution, this approach improves the internal validity of our estimates[9] and follows best practices for identifying price pass-through effects.

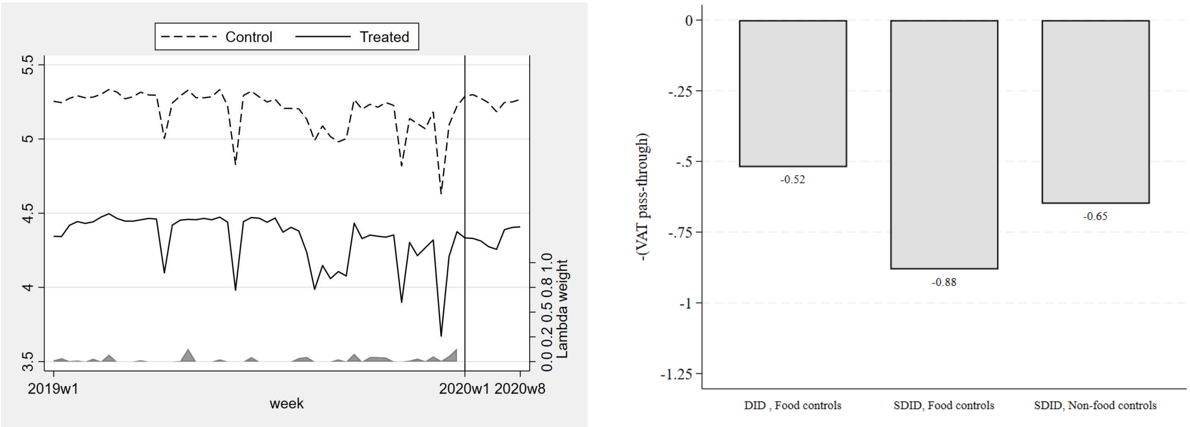
This approach also addresses the potential bias from anticipatory discounts, as documented by Buettner and Madzharova, 2021, who show that approximately one-third of the price reduction following a VAT cut occurs through discounts applied before the official implementation date. To mitigate this potential bias, we use pre-policy price dynamics as an empirical anchor. Rather than relying solely on matched control products, this strategy enables us to benchmark the price trajectory of treated items against their own historical patterns. The richness of our data facilitates this temporal comparison, which not only strengthens causal attribution but also helps to disentangle product selection bias (arising from inherent differences between treated and control items) and substitution bias (resulting from consumer behavior shifts).

Figure 2a illustrates the application of SDID with selected non-food groceries as the control group. By using time and unit-specific pre-treatment weights, the SDID first ensures that the parallel trends assumption is satisfied. Second, potential anticipation effects before

[9] The Stable Unit Treatment Value Assumption (SUTVA) requires that the price response of a product to the VAT change is unaffected by the treatment status of other products, and that treated and control items would have followed similar price trends in the absence of the policy.

but close to the start of the treatment period are mitigated by down-weighting in case of product or period-specific abnormal developments in prices. Turning to Figure 2b, it is clear that VAT pass-through estimates significantly differ if estimated by standard DID without pre-treatment weighting and with food controls (from the same 4-digit COICOP group), by SDID with matched historical price dynamics and food controls, or by SDID if the control group instead consists of non-food groceries.

Figure 2: VAT pass-through in 2020. Parallel trends, anticipation and substitution effects.



(a) Parallel trends of treated and controls (b) Removing anticipation and substitution

Note: Detailed estimation results are presented in Appendices B and C. Left panel - vertical line marks the policy change from 2020 week 1; Lambda weights, Control and Treated plots follow from equations (5) and (6). Right panel - the overall estimates differ by methods (DID vs. SDID) and control groups (foods vs. non-food groceries).

4 Results

This section presents the treatment effects associated with the VAT reclassification of 2016 and 2020 during the initial eight weeks following the policy implementation. Using the synthetic difference-in-differences method, we estimate the average treatment effect on the prices of treated products affected by the VAT cut, relative to the control group of unaffected products and the pre-reform period, as outlined in (4), (5), and (6). The resulting ATT in prices is then used to calculate the pass-through rates. We begin by presenting the static pass-through estimates (4.1) for all products and for several sample splits by product types. We then turn to the weekly dynamics of pass-through (4.2), and finally we examine demand responses, approximated by changes in purchase frequencies (4.3).

4.1 Pass-through to prices

Figure 3 illustrates the treatment effect across all product categories affected by the VAT reclassification, including bakery, dairy, vegetables, fruits, juices, and newspapers. A detailed breakdown of product groups, defined by 5-digit COICOP categories is provided in Appendix A. Since a full pass-through of the VAT reduction from 20% to 10% corresponds to an 8.3% decrease in prices, we transform the ATT estimates into implied pass-through rates for better readability.

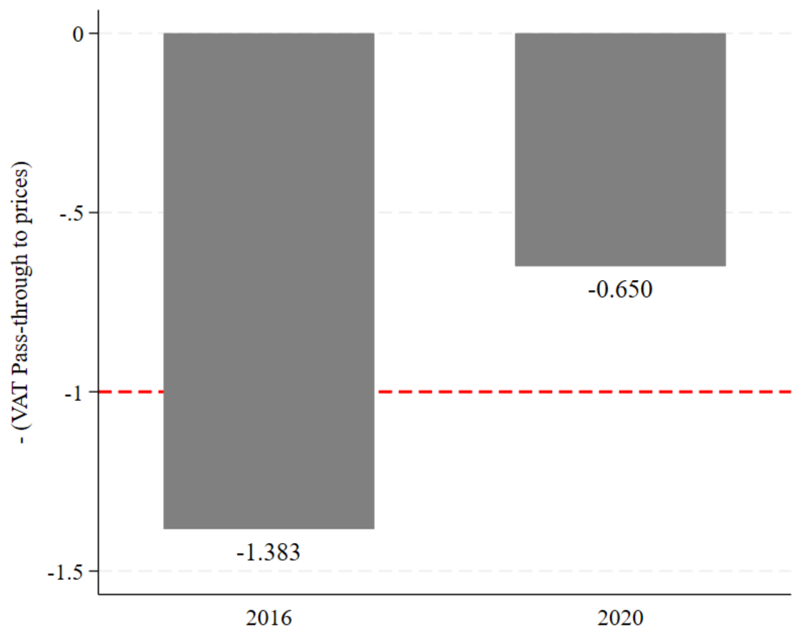
In the following sections we provide what we consider to be the most important results and findings predominantly in a graphical form. All relevant estimates linked to these figures can be found in the Appendix B.

Overall results

According to our estimates (see Figure 3), the VAT pass-through rate to prices was approximately 65% for the 2020 tax cut and 138% for the 2016 tax cut, which is more than twice the magnitude of the 2020 response. As discussed in Section 3.4, using non-food groceries as the control group helps mitigate potential biases, including anticipation effect and substitution effect from untaxed to taxed items.

The VAT pass-through we observed in 2020 is considerably lower than in 2016. Unlike the 2016 reform, which was announced well in advance, widely discussed, and targeted basic food staples, the 2020 cut was introduced hastily, and applied to a broader, more loosely defined *healthy* products. Some of the affected product were niche or premium goods, which appears to have influenced the degree of pass-through.

Figure 3: Overall VAT Pass-through to prices



Note: Detailed estimation results are presented in Appendix B.

Results align with the theoretical framework outlined in Section 3.1. When demand is inelastic and supply is elastic, tax changes tend to be fully passed through to consumer prices. For necessities like bread, butter and milk, which were the main items addressed by the reduced VAT rate, consumers are not particularly responsive to price changes, and producers or retailers have little incentive to absorb the tax cut. As a result, the observed full VAT pass-through for domestic staple goods in our results is consistent with this theoretical assumptions.

In addition, the limited public attention and weaker competitive pressure linked to the items addressed by 2020 tax reduction likely gave retailers less incentive to fully pass on the tax cut. This outcome aligns with findings from Chetty et al. (2009), who show that tax changes are more likely to be reflected in prices when they are clear, well-communicated, and easy for consumers to notice.

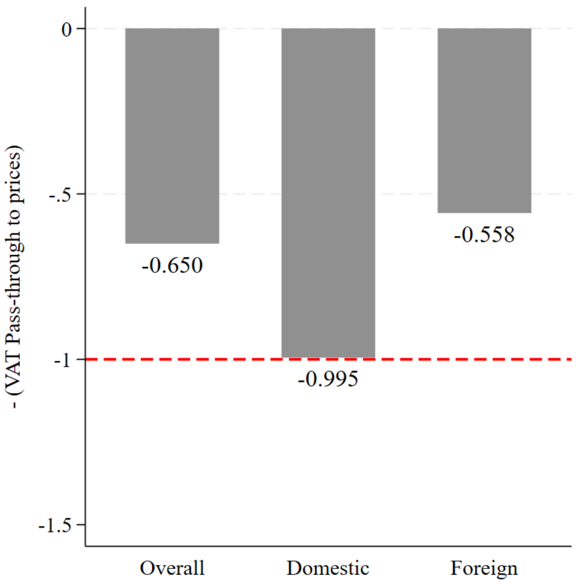
Sample split

Information from EAN barcodes allows us to distinguish between domestic and imported goods.[10] We find that VAT pass-through from the 2020 VAT cut on healthy foods was complete for domestic products, while consumers captured just over half of the tax reduction for imported goods (see Figure 4a).

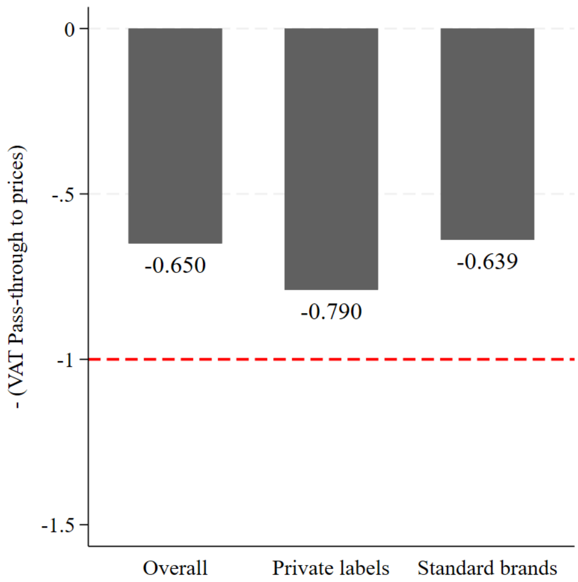
For domestic goods, competitive pressure and closer integration with local retail chains may have contributed to full pass-through, with retailers passing the tax savings entirely to consumers. In contrast, foreign products, often branded or positioned in premium categories, showed more limited pass-through. In addition to potentially more price-elastic demand for imported goods, retailers or importers may have absorbed part of the tax savings or maintained price points to preserve profit margins.

This asymmetry in pricing behavior aligns with patterns observed in prior VAT studies, such as Benzarti et al., 2020, who document variation in pass-through based on product characteristics and supplier relationships.

Figure 4: VAT Pass through to prices 2020, split samples



(a) Domestic and foreign products



(b) Private labels and standard brands

Note: Detailed estimation results are presented in Appendix B.

Products classified as private labels also exhibited somewhat higher VAT pass-through in 2020 compared to standard brands (see Figure 4b). This result is consistent with the dual

[10]We classify as domestic all standard 13-digit EAN codes that begin with the digits 858. All other 13-digit codes are identified as foreign. Approximately 100,000 product items (13.5%) have shorter EAN codes, which are mostly local bakery products (49%) and some other fresh items and items sold by weight. The latter items are excluded from the analysis of the domestic vs. foreign sample split.

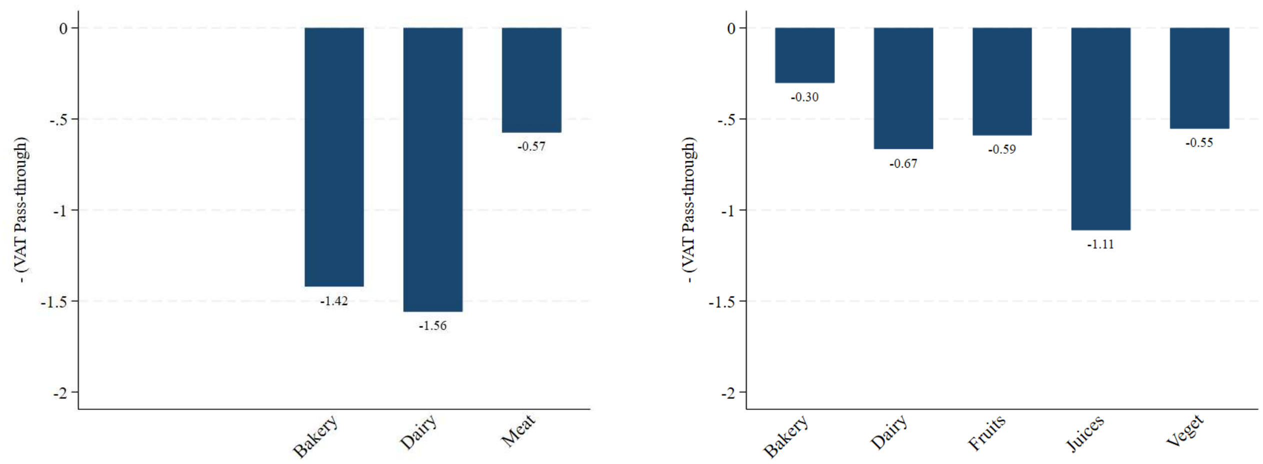
nature of private label products. Many of them are basic or staple foods, which, like other necessities, are subject to high pass-through due to inelastic demand and competitive pricing pressure. Moreover, because private labels are directly controlled by retailers, their prices may be adjusted more flexibly and transparently.

Part of the observed difference may, however, reflect a composition effect, as private-label baskets often emphasize low margin, essential items, which are more likely to exhibit full pass-through. This finding is consistent with Mayler (2014), who shows that pass-through rates differ between branded and private-label products, with the latter being more sensitive to price-based competitive dynamics.

Product types

Further insights can be gained by leveraging the rich product variety in our dataset to disaggregate the sample by product type and examine the heterogeneity in VAT pass-through rates (see Figure 5).

Figure 5: VAT Pass through to prices, product types



(a) Product types pass-through in 2016

(b) Product types pass-through in 2020

Note: Detailed estimation results are presented in Appendix B.

Notably, we observe complete pass-through for juices, a product typically considered as non-essential. This result may be explained by higher supply elasticity, as juices are generally easier to store and benefit from relatively flexible manufacturing processes.

In contrast, fresh products such as fruits and vegetables are sold in highly competitive, localized markets with volatile pricing, where daily supply shocks often dominate pricing decisions. They are perishable, have traditionally tighter profit margins, and the lower visibility of tax changes to consumers may have jointly contributed to the observed lower pass-through rates (Kosonen, 2015; Keen, 2013).

The strikingly lower VAT pass-through for bakery (0.30) and dairy (0.67) products in 2020, compared to 2016 (1.42 and 1.56), likely reflect both a shift in VAT policy focus and the heterogeneous nature of the product categories themselves. As noted above, the 2016 reform targeted staple items with high salience and low demand elasticity, such as fresh bread, butter, milk, plain cream, prompting retailers to reflect the tax cut in shelf prices. By contrast, the 2020 policy targeted a group of *healthier* foods, which included only a limited segment of bakery and dairy products, likely skewed toward premium or specialty items. These products tend to attract less consumer attention, face weaker price competition, and are also less elastic, all of which reduce the incentive for retailers to pass on the tax cut.

Overall, the observed price responses suggest that downward VAT pass-through is highly heterogeneous across product types and characteristics. On average, only a modest portion of the tax cut was absorbed into margins, with the majority passed through to consumer prices. We observed virtually no tax retention under the earlier 2016 policy intervention, which was more prominently communicated and targeted basic necessities. The highest pass-through rates, including full or in some cases greater than complete pass-through, were found in product categories likely to attract greater consumer attention. Similar patterns also emerged among certain more durable or storable goods, such as juices, where supply-side flexibility may have further facilitated the transmission of tax changes to prices.

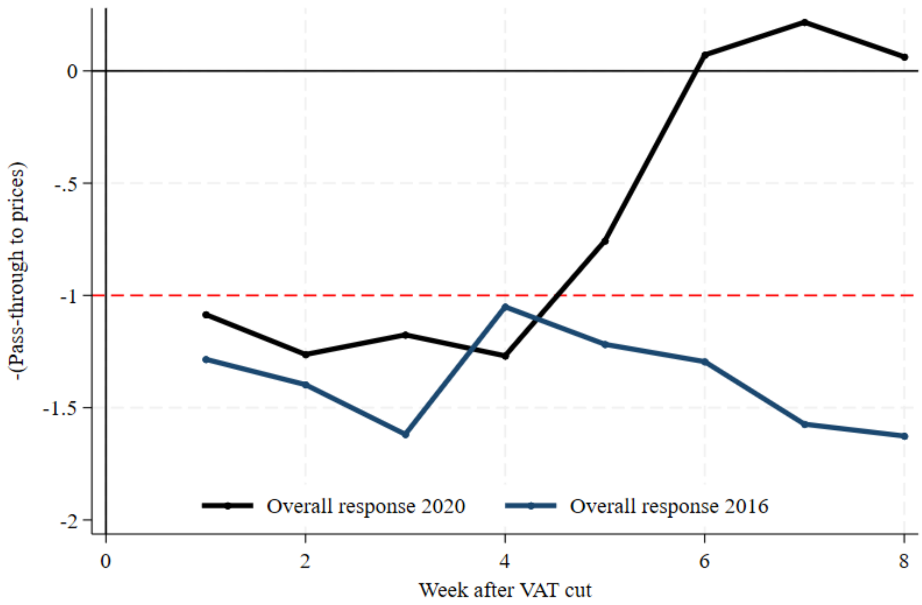
4.2 Dynamics of pass-through

So far, we have discussed only the average price adjustments associated with the VAT reduction. However, it is also informative to move beyond this static estimate and examine how prices respond over time, in an event study fashion. Using equations (5) and (6), we estimate the weekly price responses over the eight-week period following the policy implementation. As our earlier discussion and empirical findings herein suggest, policy design matters. The contrasting VAT pass-through outcomes in 2016 and 2020 highlight the significance of how policy is structured, communicated, and targeted.

The 2016 VAT cut focused on essential staple goods, i.e. products that were highly visible, widely consumed, subject to strong competitive pressure, and therefore characterized by relatively inelastic demand. The policy change was announced well in advance, and accompanied by public debate and media coverage, giving retailers time to adjust and allowing consumers to form clear expectations. Our model captures this alignment. Figure 6 shows that pass-through was immediate and complete, holding fairly steady for at least eight weeks following the change. This sustained effect aligns with economic theory on tax salience and competitive price adjustment, which suggests that well-targeted, clearly communicated policies encourage retailers to fully incorporate tax changes into shelf prices.

In contrast, the 2020 VAT reduction was introduced as a quick fix in the run-up to general elections and was publicly framed as a tax cut on *healthy* food. In practice, however, it applied to a broader and less cohesive set of items, including many with relatively elastic demand (such as specialty bakery products or fresh fish) that are more discretionary in nature. Some of these products also tend to have more volatile or rigid supply conditions, which can limit the responsiveness of producers and retailers to price-based policy changes. The combination of higher demand elasticity and lower supply elasticity likely reduced the incentive to fully pass on the VAT cut. This interpretation is consistent with our findings,

Figure 6: Dynamics of VAT pass-through

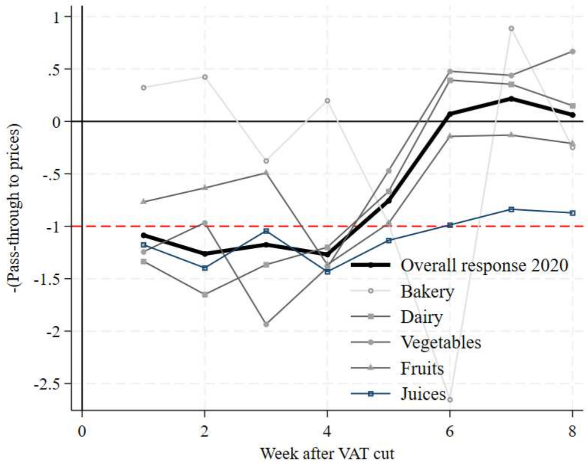


Note: Corresponding plots with 95% confidence bands are presented in Appendix C.

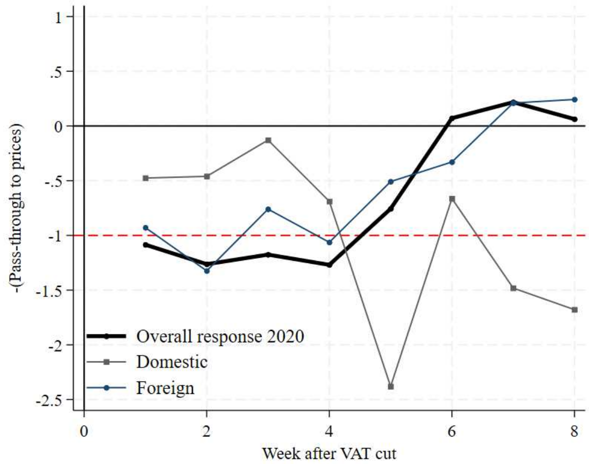
although prices initially adjusted, the effect was short-lived, with the pass-through largely reversing within six weeks.

Our findings are also consistent with Chetty et al. (2009), who show that tax changes with low salience and weak consumer expectations often lead to muted price adjustments. They also align with insights from Weyl and Fabinger (2013) regarding the influence of market power and supply-side frictions on tax incidence. Taken together, the 2020 estimates suggest that the limited and short-lived price response reflects weaker policy targeting and the inclusion of products with higher demand elasticity and less flexible supply. Unlike the 2016 reform, the VAT cut did not align with the conditions typcially associated with full pass-through.

Figure 7: Dynamics of VAT pass through to prices, product types



(a) Product types, 2020



(b) Domestic and foreign, 2020

Note: Corresponding plots with 95% confidence bands are presented in Appendix C.

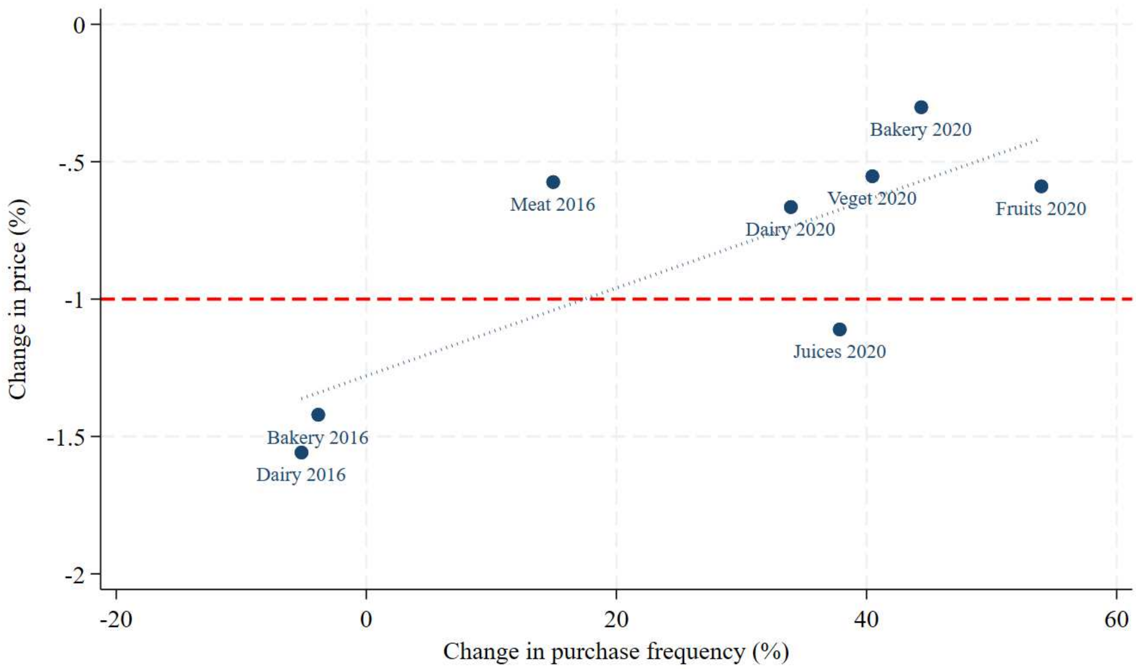
A more detailed breakdown by product type is shown in Figure 7. It reveals that the reversal of the 2020 VAT pass-through after four weeks was driven primarily by fruits, vegetables and dairy products, particularly those of foreign origin. Additional estimates of 2020 pass-through dynamics by product category and sample splits are provided in Appendix C.

4.3 Demand effects

We use purchase frequencies as a proxy for quantities sold. While this does not directly measure demand responses, the extensive coverage of the dataset and detailed product listings allow this proxy to reasonably capture consumer sensitivity to policy shocks reflected in price dynamics. Using the same methodology as before (SDID), we estimate these proxy demand responses across different product types and categories.

To contextualize the VAT-cut-driven price response and proxy demand response, we present paired estimates of product types across the two VAT policy changes in a scatter plot on Figure 8.

Figure 8: Paired estimates of VAT pass through and quantities by product types



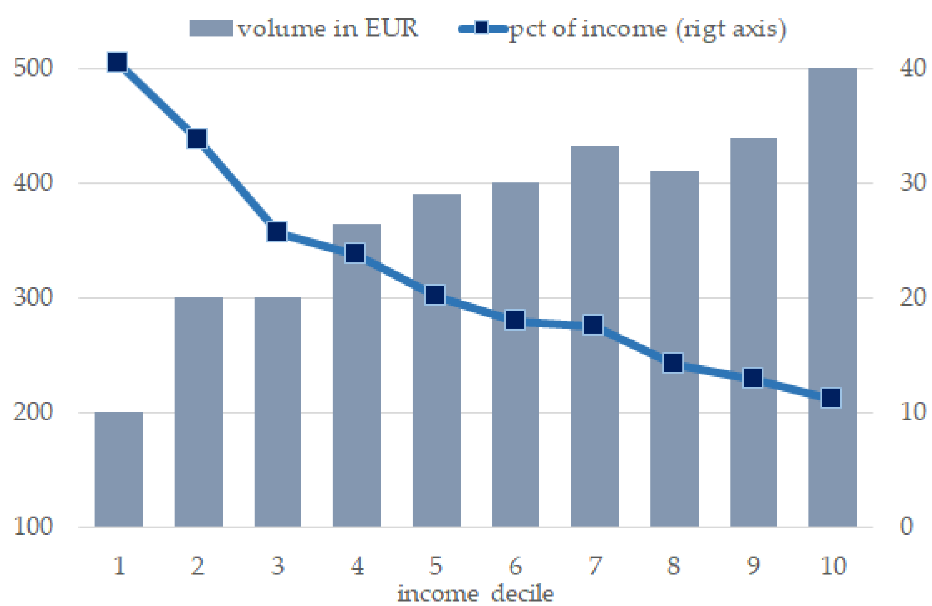
The association between VAT pass-through and changes in purchase frequency aligns with standard consumer theory, which predicts that price changes have smaller effects on the demand for goods with inelastic consumption patterns. Essential products, such as staples, dairy, and bread, exhibit high pass-through rates because their demand is relatively unresponsive to price. This makes it easier for retailers to fully pass tax changes onto consumers without risking significant drops in sales. These goods are often consumed habitually and in fixed quantities, particularly among lower-income households, where food budgets are constrained and substitution options are limited. Accordingly, we observe virtually no change in purchase frequencies. This pattern is also consistent with findings from the empirical literature, e.g. Chetty et al. (2009), who show that pass-through is more complete when consumer demand is less elastic and consumer expectations are well-formed.

On the other hand, product types such as fruits and vegetables, which show lower VAT pass-through and higher increases in purchase frequency, tend to be more price-sensitive and discretionary in nature. Consumers adjust their consumption of these goods more flexibly in response to price changes, making retailers less inclined to fully pass on VAT cuts, particularly in more competitive or differentiated product categories. This dynamic reflects the interplay between tax salience, demand responsiveness, and product substitutability, as discussed by Weyl and Fabinger (2013) or Fuest et al. (2024). The observed pattern thus reinforces the idea that both the structure of demand and the nature of the good jointly determine how tax changes are transmitted to retail prices and consumer behavior.

5 Discussion

As outlined in Section 3.1, economic theory predicts higher VAT pass-through for goods with price-inelastic demand, most notably, essential food items. However, the perceived essentiality of a product often depends on a country's overall income level. In Slovakia, food accounts for nearly 20% of household consumption, and staple items such as bakery goods and certain dairy products commonly regarded as necessities. By contrast, for a significant portion of households, items like fruits and vegetables may be considered as premium, discretionary, or even luxury goods.

Figure 9: Food consumption across household income groups.

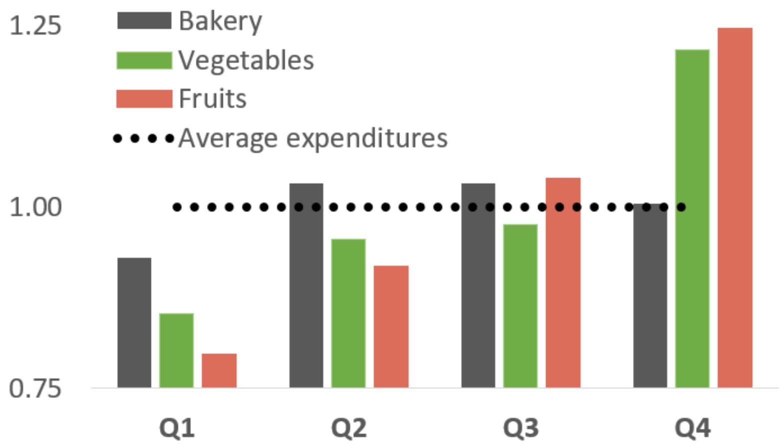


Source: The Slovak Household Finance and Consumption Survey from 2021.

The relatively high share of food expenditures in the consumer basket, ranging from 40% in the lowest income decile to 10% in the highest (see Figure 9) highlights another important dimension in the variation of VAT pass-through across product types. In an economy with a large share of hand-to-mouth consumers, demand for essential goods, which constitute a major part of household spending, tends to be more inelastic. As a result, the burden of VAT incidence shifts toward staples rather than premium products, whose aggregate demand is comparatively limited in lower-income settings.

Consistent with the existing literature, bakery essentials, characterized by price inelastic demand, exhibit full VAT pass-through, whereas fruits and vegetables show only partial pass-through, accompanied by substantial demand elasticity. This pattern suggests that for a significant share of consumers, fruits and vegetables are perceived as premium goods. This distinction is further highlighted by the nearly unchanged demand for bakery products across all income quartiles, in contrast to fruit and vegetable expenditures, which also rise progressively with income (see Figure 10).

Figure 10: Household expenditure on foods by income quartiles (fractions of sample mean).



Note: Calculations from Household Budget Survey, 2021. Household size is adjusted using the OECD equivalence scale, which assigns a weight of 1 to the first household member, 0.7 to each additional member aged 14 or older, and 0.5 to each child under 14.

In addition to demand-side considerations, such as whether goods are perceived as necessities or luxuries, limited downward pass-through may also arise from various supply-side factors, including market structure, the intensity of competition, retailer-specific characteristics, and supply elasticity. Among these, market competition consistently emerges as a key determinant of pass-through behavior. Empirical studies, including Frey and Haucap (2024) and Dimitrakopoulou et al. (2024) find that more competitive markets and inelastic demand conditions are associated with faster and more complete pass-through. Similarly, large retail chains, benefiting from economies of scale and strategic pricing capabilities, tend to pass on tax reductions more fully than smaller, independent retailers (Benzarti et al., 2024). Moreover, downward pass-through is often more constrained during economic downturns or periods of heightened uncertainty (Fuest et al., 2024).

Recognizing that a reduced VAT does not always fully pass through to prices raises the key question of how to design an optimal policy. Maximizing the benefits of a VAT reduction can follow two main approaches: first, as a tool to support vulnerable households, and second, as a tool to provide fiscal stimulus by reducing tax incidence on specific segments of the corporate sector. In terms of redistribution, we find that full pass-through primarily occurs in essential food items, which are most relevant to lower-income consumers. As a result, they benefit the most from the full pass-through. As regards the impact on firms, if domestic production is concentrated in essential foods with price inelastic demand, the VAT reduction may disproportionally benefit foreign producers of food products with a high price elasticity, limiting gains for local producers. In contrast, when a VAT tax cut targets domestically produced goods and services, an incomplete pass-through lowers value added tax incidence on domestic firms.

A certain limitation of our analysis is that we observe price developments from only a single supermarket chain. Nevertheless, we consider our results to be broadly generalizable for two main reasons. First, the chain in question holds a significant market share, which is particularly relevant given the high degree of market concentration in Slovak retail sector, where a small number of supermarket chains control most of the market (Špička, 2016). Second, our estimated pass-through rate of 65% for the 2020 VAT reduction, applied to a broader set of products, closely aligns with recent evidence from other European contexts. Studies of the 2020 temporary VAT cut in Germany (Fuest et al., 2024), the 2023 VAT reduction in Spain (Forteza et al., 2024), and the permanent VAT cut on oil in Greece (Kampouris, 2023) all report incomplete yet significant pass-through, typically ranging from 50% to 70%, depending on product type, timing, and market competitiveness.

These parallels suggest that our findings are broadly in line with empirical patterns observed in comparable settings. In contrast, the full pass-through we documented for the 2016 reform is less commonly reported in the literature, though not unprecedented, with similar outcomes observed in a few select cases (e.g., Bernardino et al., 2025; Gaarder, 2019; Poterba, 1996).

6 Conclusions

This paper examined the effects of two VAT rate cuts in Slovakia, in 2016 and 2020, that reduced the tax rate from 20% to 10% on selected grocery products. Using high-resolution scanner data combined with a synthetic difference-in-differences approach, we find that the pass-through of VAT reductions to consumer prices is neither uniform nor complete. Instead, it varies significantly across products and over time, shaped by factors such as consumer demand responses, supply-side conditions, and the specifics of policy design and implementation.

The 2016 VAT reform, which targeted essential staple foods, resulted in a nearly complete and sustained pass-through to consumer prices. In contrast, the 2020 tax cut produced more uneven outcomes. On average, just over half of the tax reduction was passed through to lower retail prices, with substantial variation across product categories. High or even overshifting pass-through was observed for bakery goods and private-label products, whereas fruits, vegetables, and premium or imported items experienced weaker and less persistent price adjustments. These findings are consistent with theoretical predictions: goods characterized by inelastic demand and elastic supply, such as basic staples and retailer-controlled products, are more likely to display stronger price responses to tax changes.

The temporal patterns of price adjustment further highlight the critical role of clear policy communication and precise targeting. The 2016 VAT reduction was well-publicized and concentrated on essential, high-visibility goods, resulting in price effects that remained stable for at least two months. In contrast, the 2020 measure was introduced with limited public notice and applied to a vaguely defined category of *healthy* products. This lack of clarity was reflected in the market response, i.e. the resulting price declines were short-lived, with pass-through effects largely dissipating within six weeks across most affected categories.

On the demand side, consumption of essential goods remained relatively stable following price changes, whereas more discretionary items, such as fruits and vegetables, exhibited greater price sensitivity. These behavioral patterns underscore the influence of income-related consumption habits and highlight how tax policy can produce uneven effects across different household groups.

Overall, our findings suggest that VAT reductions can provide meaningful price relief for consumers, especially when they target goods with low demand elasticity and are clearly communicated. However, weakly signaled reforms may generate only temporary or uneven effects, and in some case, may produce regressive outcomes or disproportionally benefit higher-income households. Limited pass-through may not only reflect retailer inertia but also strategic pricing decisions aimed margin enhancements - an outcome that may be unintended, or in certain contexts, quietly accepted as a side effect of the policy. Careful attention to policy framing, product selection, and market conditions is therefore essential to maximize both the effectiveness and equity of VAT-based interventions.

References

Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of california's tobacco control program. *Journal of the American statistical Association*, *105*(490), 493–505.

Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W., & Wager, S. (2021). Synthetic difference-in-differences. *American Economic Review*, *111*(12), 4088–4118.

Bellon, M., & Copestake, A. (2022). Supply and demand determinants of heterogeneous VAT pass-through.

Benedek, D., De Mooij, R. A., Keen, M., & Wingender, P. (2020). Varieties of VAT pass through. *International Tax and Public Finance*, *27*(4), 890–930.

Benzarti, Y. (2024). *Tax incidence anomalies* (Working Paper No. 32819). National Bureau of Economic Research.

Benzarti, Y., Carloni, D., Harju, J., & Kosonen, T. (2020). What goes up may not come down: Asymmetric incidence of value-added taxes. *Journal of Political Economy*, *128*(12).

Benzarti, Y., Garriga, S., & Tortarolo, D. (2024). *Can cuts and anti-profiteering measures dampen the effects of food price inflation?* (Working Paper No. 31938). National Bureau of Economic Research.

Benzarti, Y., Garriga, S., & Tortarolo, D. (2023). The incidence of vat: Evidence from argentina. *American Economic Journal: Economic Policy*, *15*(2), 405–438.

Bernardino, T., Gabriel, R. D., Quelhas, J., & Silva-Pereira, M. (2025). The full, persistent, and symmetric pass-through of a temporary vat cut. *Journal of Public Economics*, *248*, 105416.

Besley, T., & Rosen, H. S. (1999). Sales taxes and prices: An empirical analysis. *National Tax Journal*, *52*(2), 157–178.

Blundell, R. (2009). Assessing the temporary VAT cut policy in the UK. *Fiscal studies*, *30*(1), 31–38.

Buettner, T., Hechtner, F., & Madzharova, B. (2023). Taxes and gender equality: The incidence of the 'tampon tax'. *CESifo Working Paper Series No. 10580*.

Buettner, T., & Madzharova, B. (2021). Unit sales and price effects of preannounced consumption tax reforms: Micro-level evidence from european VAT. *American Economic Journal: Economic Policy*, *13*(3), 103–134.

Carbonnier, C. (2005). Is Tax Shifting Asymmetric? Evidence from French VAT reforms, 1995-2000. *PSE Working Papers*.

Chetty, R., Looney, A., & Kroft, K. (2009). Salience and taxation: Theory and evidence. *American Economic Review*, *99*(4), 1145–1177.

Clarke, D., Pailañir, D., Athey, S., & Imbens, G. (2024). On synthetic difference-in-differences and related estimation methods in stata. *The Stata Journal*, *24*(4), 557–598.

Crossley, T. F., Low, H. W., & Sleeman, C. (2014). *Using a temporary indirect tax cut as a fiscal stimulus: Evidence from the UK* (tech. rep.). IFS Working Papers.

De Amores, A., Barrios, S., Speitmann, R., & Stoehlker, D. (2023). *Price effects of temporary VAT rate cuts: Evidence from Spanish supermarkets* (tech. rep.). European Commission.

Dimitrakopoulou, L., Genakos, C., Kampouris, T., & Papadokonstantaki, S. (2024). Vat pass-through and competition: Evidence from the Greek islands. *International Journal of Industrial Organization*, *97*.

ECB. (2022). *Study on the payment attitudes of consumers in the euro area (space)*. European Central Bank.

ECB. (2023). *Price setting during the coronavirus (COVID-19) pandemic*. European Central Bank.

Forteza, N., Prades, E., & Roca, M. (2024). *Analysing the VAT cut pass-through in spain using web-scraped supermarket data and machine learning* (Working Paper No. 2417). Banco de España.

Frey, A., & Haucap, J. (2024). VAT pass-through: The case of a large and permanent reduction in the market for menstrual hygiene products. *International Tax and Public Finance*, *31*(1), 160–202.

Fuest, C., Neumeier, F., & Stöhlker, D. (2024). The pass-through of temporary VAT rate cuts: Evidence from German supermarket retail. *International Tax and Public Finance*.

Gaarder, I. (2019). Incidence and distributional effects of value added taxes. *The Economic Journal*, *129*(618), 853–876.

Gorodnichenko, Y., Sheremirov, V., & Talavera, O. (2018). Price Setting in Online Markets: Does IT Click? *Journal of the European Economic Association*, *16*(6), 1764–1811.

Harberger, A. C. (1962). The incidence of the corporation income tax. *Journal of Political economy*, *70*(3), 215–240.

Hindriks, J., & Serse, V. (2019). Heterogeneity in the tax pass-through to spirit retail prices: Evidence from belgium. *Journal of Public Economics*, *176*, 142–160.

Kampouris, N. (2023). How competitive is pass-through? evidence from VAT reforms on Greek Islands. *European Economic Review*, *157*, 104487.

Keen, M. (2013). The anatomy of the VAT. *National Tax Journal*, *66*(2), 423–446.

Kosonen, T. (2015). More and cheaper haircuts after VAT cut? on the efficiency and incidence of service sector consumption taxes. *Journal of Public Economics*, *131*, 87–100.

Mayler, D. (2014). Price setting and vat pass-through: Evidence from scanner data. *Applied Economics Letters*, *21*(18), 1285–1289.

Nakamura, E., & Steinsson, J. (2008). Five Facts about Prices: A Reevaluation of Menu Cost Models. *The Quarterly Journal of Economics*, *123*(4), 1415–1464.

Poterba, J. M. (1996). Retail price reactions to changes in state and local sales taxes. *National Tax Journal*, *49*(2), 165–176.

Ramsey, F. P. (1927). A contribution to the theory of taxation. *The economic journal*, *37*(145), 47–61.

Špička, J. (2016). Market concentration and profitability of the grocery retailers in central europe. *Central European Business Review*, *5*(3), 5–24.

Tirole, J. (1988). *The theory of industrial organization*. MIT Press.

Tóth, P., Cupák, A., & Rizov, M. (2021). Measuring the efficiency of VAT reforms: A demand system simulation approach. *Oxford Economic Papers*, *73*(3), 1218–1243.

Vermeulen, P., & Gábor, E. (2014). New evidence on elementary index bias. *ECB Working Paper Series*.

Weyl, E. G., & Fabinger, M. (2013). Pass-through as an economic tool: Principles of incidence under imperfect competition. *Journal of Political Economy*, *121*(3), 528–583.

Appendices

A List of affected products and their COICOP classification

Table A1: Categories of products affected by VAT decrease to 10% (2016 and 2020 tax reforms).

Tariff Code No.	Description	Year of VAT Decrease
0201	Beef meat, fresh or chilled (excluding wild cattle)	2016
ex 0203	Pork, fresh or chilled (only domestic)	2016
ex 0204	Sheep or goat meat, fresh or chilled (excluding wild sheep and goats)	2016
ex 0207	Poultry meat and edible offal, fresh or chilled (only domestic)	2016
ex 0208	Other meat and edible offal, fresh or chilled (only from domestic rabbits)	2016
ex 0301	Live fish (only freshwater, excluding ornamental fish)	2016
ex 0302	Fish, fresh or chilled (excluding fish fillets and other fish meat)	2020
ex 0304	Fish fillets and other fish meat, fresh, chilled, or frozen (only freshwater)	2016
0401	Milk and cream, not concentrated nor sweetened	2016
ex 0405 10	Butter	2016
0403	Sour milk, cream, yogurt, other similar products	2020
0406	Cheese and curd (only sheep bryndza per specific regulation)	2020
0409 00	Natural honey	2020
0701	Potatoes, fresh or chilled	2020
0702 00 00	Tomatoes, fresh or chilled	2020
0703	Onions, shallots, garlic, leeks, and other alliaceous vegetables, fresh or chilled	2020
0704	Cabbage, cauliflower, kale, and similar edible brassicas, fresh or chilled	2020
0705	Lettuce and chicory, fresh or chilled	2020
0707 00	Fresh or chilled cucumbers and gherkins	2020
0708	Legumes, shelled or unshelled, fresh or chilled	2020
0709	Other vegetables, fresh or chilled	2020
0808	Apples, pears, and quinces, fresh	2020
ex 1905	Fresh bread (2016); Bakery products excl. bread, incl. sweet bakery, fresh only, weight 40g to 50g (2020)	2016 / 2020
ex 2009	Fruit and vegetable juices, not fermented, with or without added sugar	2020
4902 10 00	Newspapers and magazines with limited advertising and erotic content	2020

Note: The abbreviation **"ex"** indicates that the 10% VAT rate applies only to a specific part of the item or category listed. Where both 2016 and 2020 apply, the entry was extended in 2020 to cover additional products under the same tarrif code.

Table A2: Affected Product Composition by COICOP Subcategories

Group	COICOP5	Label	2016 Reform	2020 Reform
Bakery			**256**	**14**
	01.1.1.	Cereals and cereal products	256	14
Meat			**16**	**–**
	01.1.2.	Live animals, meat and other parts of slaughtered land animals	7	–
	01.1.3.	Fish and other seafood	9	–
Dairy			**12**	**241**
	01.1.4.1	Raw and whole milk	6	–
	01.1.4.2	Skimmed milk	6	–
	01.1.4.5	Cheese	–	5
	01.1.4.6	Yoghurt and similar products	–	233
	01.1.4.7	Milk-based dessert and beverages	–	3
Fruit			**–**	**49**
	01.1.6.3	Stone fruits and pome fruits, fresh	–	28
	01.1.8.3	Jams, marmalades, honey	–	21
Vegetables			**–**	**66**
	01.1.7.1	Leafy or stem vegetables, fresh or chilled	–	9
	01.1.7.2	Fruit-bearing vegetables, fresh or chilled	–	30
	01.1.7.4	Other vegetables, fresh or chilled	–	19
	01.1.7.5	Tubers, plantains and cooking bananas	–	8
Juice			**–**	**87**
	01.2.1.0	Fruit and vegetable juices	–	87

Table A3: Descriptive Statistics - Untreated Foods

Year	Category (Breakdown)	N (products)	Mean Price (€)	Std. Dev. Price (€)
2020	**Untreated Foods**	**2,169**	**1.48**	**1.75**
	Foreign	1,108	1.83	2.28
	Domestic	793	1.25	0.83
	Non-Private Label	1,676	1.52	1.78
	Private Label	493	1.34	1.66
	Bakery	1,235	1.19	1.46
	Dairy	488	1.91	2.48
	Vegetables	30	1.34	1.26
	Fruit	82	2.02	1.01
	Juices	89	1.15	0.54
2016	**Untreated Foods**	**945**	**1.66**	**2.23**
	Foreign	486	2.22	2.68
	Domestic	332	1.32	1.56
	Standard Product	666	1.36	1.71
	Private Label	279	2.37	3.04
	Bakery	567	0.90	1.22
	Dairy	46	3.75	3.00
	Meat	332	2.67	2.80

Note: Data refer to balanced panels of products available in weeks 2015w26-2016w8 and 2019w1-2020w8, respectively. Fish are merged into the "Meat" category and jams are merged into the "Fruits" category.

B Average Treatment Effects on the Treated (ATT)

Table B1: ATT for prices, 2020 VAT cut

Group	ATT	Standard Error	95% Confidence Interval		N
Overall	-0.0541	0.0086	-0.0709	-0.0374	2177
Foreign	-0.0465	0.0089	-0.0638	-0.0291	1813
Domestic	-0.0829	0.0177	-0.1176	-0.0482	242
Non-private	-0.0532	0.0086	-0.0702	-0.0363	1879
Private	-0.0658	0.0170	-0.0991	-0.0326	294
Bakery	-0.0251	0.0393	-0.1022	0.0519	1719
Dairy	-0.0554	0.0098	-0.0746	-0.0362	1946
Vegetables	-0.0461	0.0231	-0.0914	-0.0007	1771
Fruits	-0.0491	0.0144	-0.0774	-0.0209	1754
Juices	-0.0925	0.0107	-0.1135	-0.0715	1792

Note: Standard errors are obtained from 50 bootstrap replications. 95% confidence intervals are based on large-sample approximations, refer to Arkhangelsky et al. (2021) for theoretical derivations. N denotes the number of cross-sectional units in balanced panels for the period 2019 week 1 - 2020 week 8.

Table B2: ATT for pruchase frequencies, 2020 VAT cut

Group	ATT	Standard Error	95% Confidence Interval		N
Overall	0.3835	0.0327	0.3194	0.4475	2177
Foreign	0.4214	0.0395	0.3439	0.4989	1813
Domestic	0.1361	0.0985	-0.0570	0.3291	242
Non-private	0.3274	0.0287	0.2712	0.3836	1879
Private	0.4196	0.1273	0.1702	0.6691	294
Bakery	0.4438	0.1607	0.1288	0.7587	1719
Dairy	0.3395	0.0302	0.2803	0.3987	1946
Vegetables	0.4047	0.0605	0.2861	0.5233	1771
Fruits	0.5398	0.1060	0.3319	0.7476	1754
Juices	0.3786	0.0596	0.2617	0.4955	1792

Note: Standard errors are obtained from 50 bootstrap replications. 95% confidence intervals are based on large-sample approximations. Refer to Arkhangelsky et al. (2021) for theoretical derivations. N denotes the number of cross-sectional units in balanced panels for the period 2019 week 1 - 2020 week 8.

Table B3: ATT for prices, 2016 VAT cut

Group	ATT	Standard Error	95% Confidence Interval		N
Overall	-0.1152	0.0055	-0.126	-0.1044	2539
Foreign	-0.0732	0.0286	-0.1294	-0.0171	2099
Domestic	-0.0914	0.0137	-0.1183	-0.0646	296
Non-private	-0.127	0.0082	-0.1429	-0.111	2281
Private	-0.0677	0.012	-0.0911	-0.0442	258
Bakery	-0.1184	0.0063	-0.1308	-0.106	2511
Dairy	-0.1299	0.0245	-0.1778	-0.0819	2267
Meat	-0.0478	0.0263	-0.0994	0.0038	2271

Note: Standard errors are obtained from 50 bootstrap replications. 95% confidence intervals are based on large-sample approximations. Refer to Arkhangelsky et al. (2021) for theoretical derivations. N denotes the number of cross-sectional units in balanced panels for the period 2015 week 26 (July) - 2016 week 8.

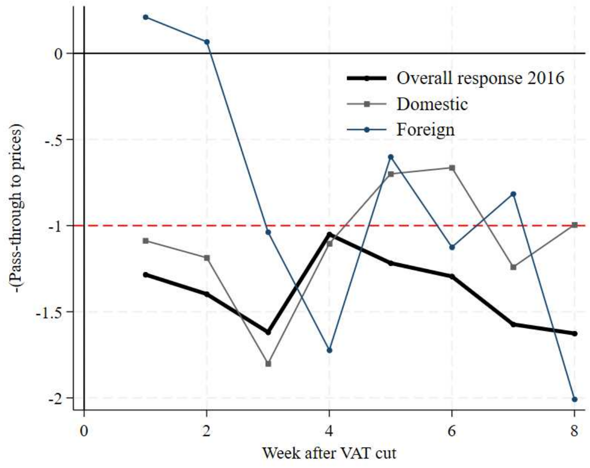
Table B4: ATT for purchase frequencies, 2016 VAT cut

Group	ATT	Standard Error	95% Confidence Interval		N
Overall	-0.0283	0.0199	-0.0674	0.0107	2539
Foreign	0.1151	0.0781	-0.0381	0.2682	2099
Domestic	-0.0052	0.0523	-0.1077	0.0973	296
Non-private	-0.0439	0.0213	-0.0856	-0.0022	2281
Private	-0.0002	0.0446	-0.0877	0.0872	258
Bakery	-0.0384	0.0197	-0.0771	0.0002	2511
Dairy	-0.0518	0.0973	-0.2426	0.1389	2267

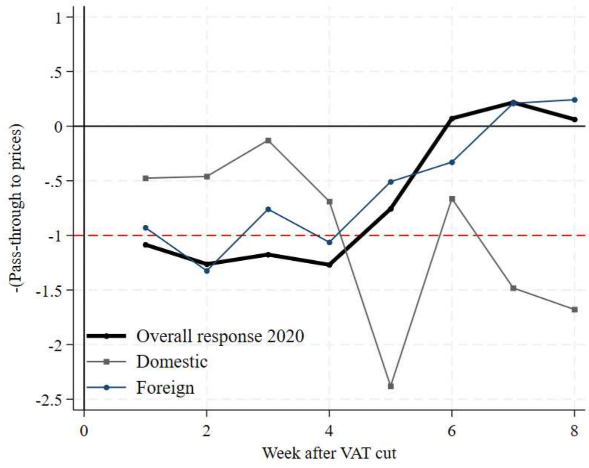
Note: Standard errors are obtained from 50 bootstrap replications. 95% confidence intervals are based on large-sample approximations. Refer to Arkhangelsky et al. (2021) for theoretical derivations. N denotes the number of cross-sectional units in balanced panels for the period 2015 week 26 (July) - 2016 week 8.

C Breakdown of VAT pass-through dynamics

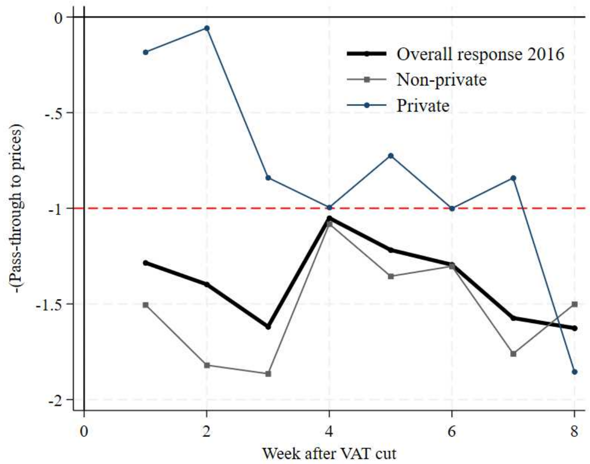
Figure C1: Dynamics of VAT pass-through, sample splits



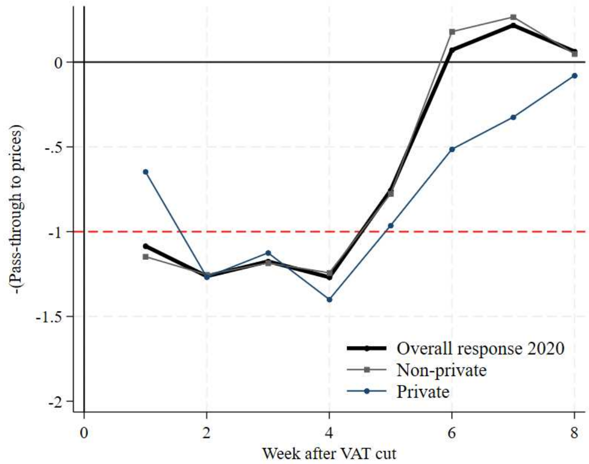
(a) Domestic and foreign, 2016



(b) Domestic and foreign, 2020

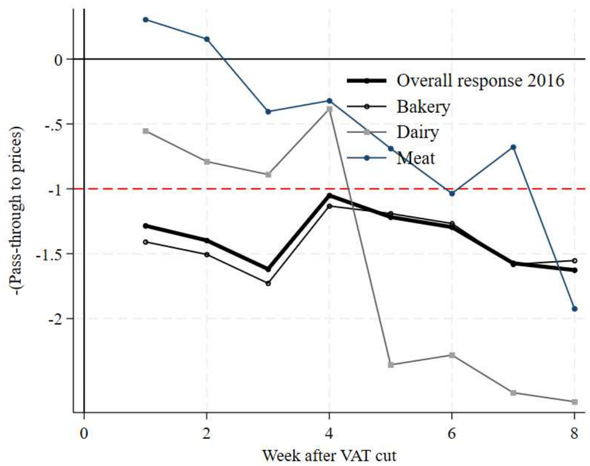


(c) Private labels, 2016

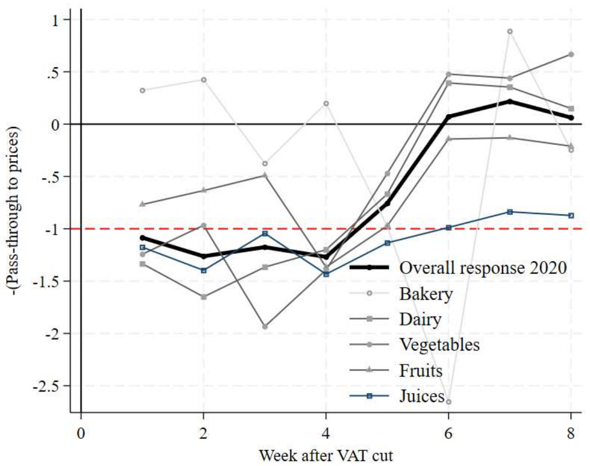


(d) Private labels, 2020

Figure C2: Dynamics of VAT pass through to prices, product types

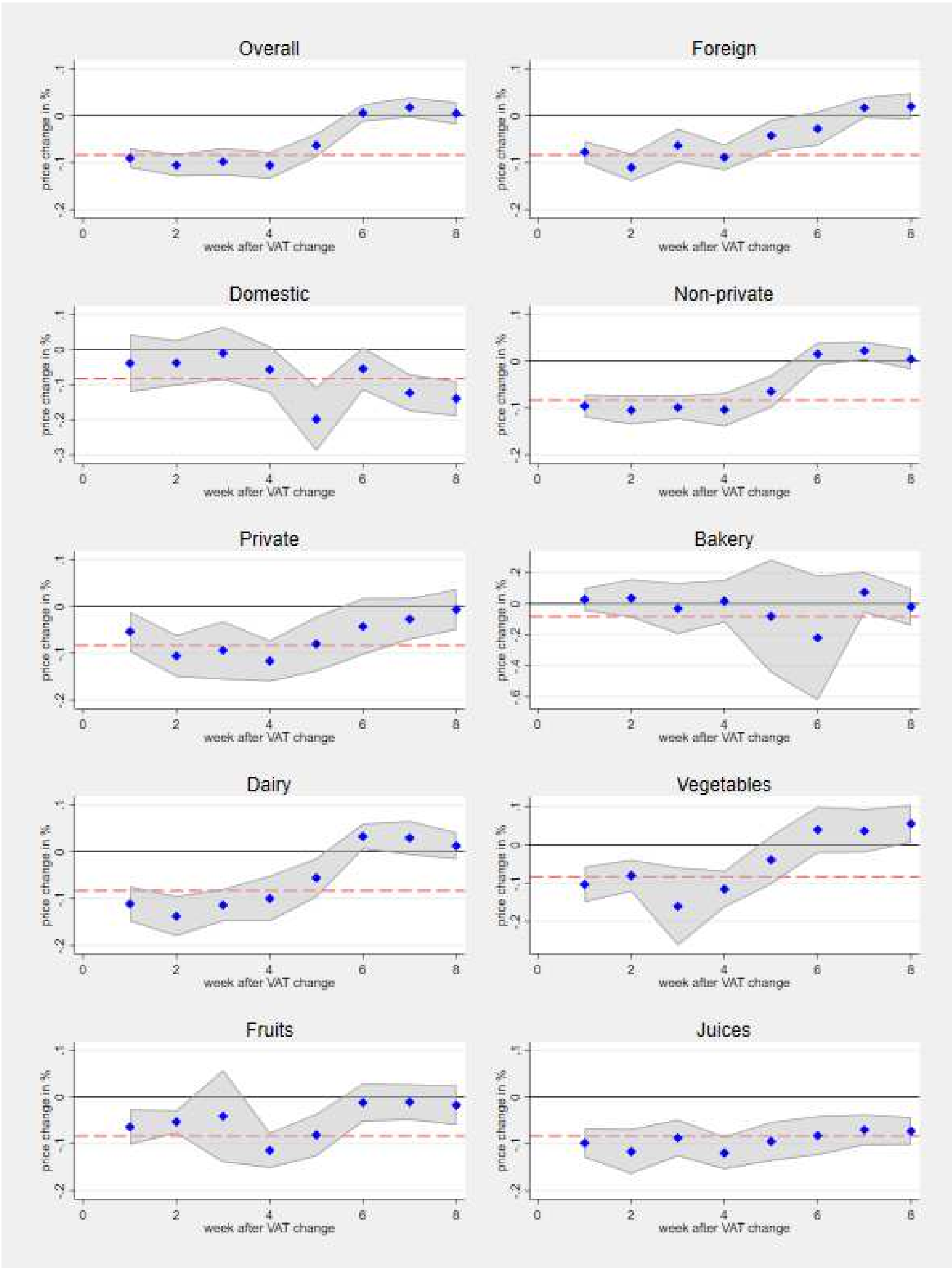


(a) Product types, 2016



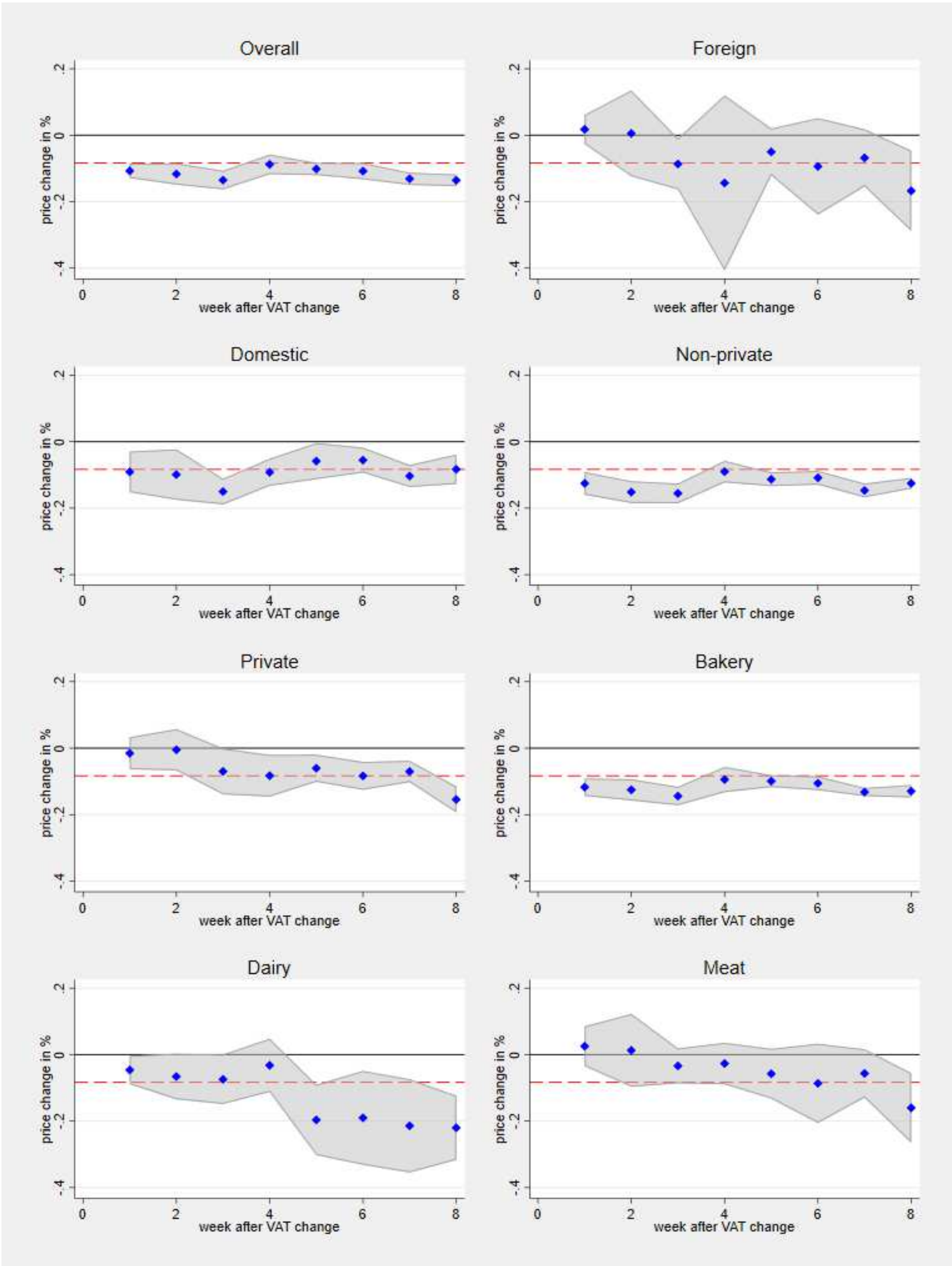
(b) Product types, 2020

Figure C3: Dynamic price effects with confidence intervals (2020)



Note: Dots denote point estimates, shaded areas represent 95% confidence intervals based on 50 bootstrap replications. See Clarke et al. (2024), section 4.4 for more details.

Figure C4: Dynamic price effects with confidence intervals (2016)



Note: Dots denote point estimates, shaded areas represent 95% confidence intervals based on 50 bootstrap replications. See Clarke et al. (2024), section 4.4 for more details.