



The pass-through of temporary VAT rate cuts: evidence from German supermarket retail

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Abstract

We study the price effects of a temporary VAT reduction in Germany using a web-scraped dataset of daily prices of more than 60000 supermarket products. For causal identification, we compare the development of German prices to those in Austria. We find that the reduction of VAT rates led to a price decrease of 1.3%, implying that 70% of the tax cut were passed on to consumers. Moreover, the pass-through is higher for vertically integrated products (private label) than for independent brands. This is consistent with menu cost theories and theories predicting that price markups act as a buffer for cost shocks.

Keywords Value added tax · Tax incidence · Fiscal policy · Price effects · Market structure

JEL Classification E31 · H22 · H25

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1 Introduction

On June 3, 2020, the German government announced a large fiscal stimulus package to combat the economic downturn caused by the Corona pandemic. The package included spending on infrastructure and research, tax deferrals for firms, and, as its largest item and to the surprise of the general public, a temporary reduction of the value added tax (VAT). Limited explicitly to the second half of 2020, the standard VAT rate was reduced from 19 to 16% and the reduced rate, which applies broadly to ‘basic goods and foodstuff,’ was reduced from 7 to 5%. The VAT rates returned to their previous levels on January 1, 2021.

Temporary VAT rate cuts are a relatively new instrument in the fiscal policy toolkit. As explained in Blundell (2009) and Crossley et al. (2009), its objective is to stimulate demand primarily by creating incentives for consumers to bring forward spending. However, this can only work if the VAT rate cut is passed on to consumers in the form of lower prices.¹

While the pass-through of permanent VAT changes has been studied extensively (see e.g. Benedek et al., 2020; Benzarti et al., 2020; Carbonnier, 2007; Kosonen, 2015), very little is known about the price effects of temporary VAT changes, not least because this instrument has been rarely used. One exception to which we will return below is the VAT cut in the UK in 2008/2009. There are reasons to believe that the pass-through could be different for temporary as opposed to permanent VAT changes, most importantly because consumers are incentivized to bring forward spending and (menu-)costs for firms to adjust prices have to be borne twice when VAT rates are changed only temporarily.

In this study, we use daily retail prices from German and Austrian supermarkets to track the impact of the temporary VAT reduction in Germany on consumer prices over time. In our empirical analysis, Austrian supermarket prices serve as a counterfactual. Austria adopted a stimulus package including similar measures as Germany at around the same time. However, Austria did not reduce VAT rates in the retail market.² We use daily prices for roughly 55,000 products from REWE, a German supermarket chain, and for 8500 products from Billa in Austria. The data were collected using a webscraping algorithm. It is the objective of our analysis to measure the overall VAT pass-through and to investigate whether different product groups were affected differently.³ Our data also allow us to study how a particular aspect of market structure, vertical integration between suppliers and retailers,

¹ One could object that, even without pass-through, a VAT rate cut may boost economic activity because it allows firms to secure jobs or maintain investment. But a general VAT rate cut helps firms in proportion to their sales. The economic consequences of the COVID-19 pandemic for firms were very heterogeneous. A general VAT cut would channel most of the help to the winners of the crisis, like digital companies or supermarkets, which were exempt from lockdowns. This suggests that, to help firms affected by the crisis, other instruments targeting the most affected sectors and companies would be more effective.

² Austria as well as Germany introduced a sector specific VAT cut for hotels and restaurants. In Germany this was on top of the general VAT cut. This will be explained in greater detail in Sect. 2.

³ Among other things, we investigate whether the pass-through varies across products taxed at the regular VAT rate vs. products taxed at the reduced VAT rate and private label vs. brand products. This cannot be done using CPI data.

affects pass-through. Understanding these impacts is important to draw lessons for the management of future economic crises.

We find a large and immediate pass-through of the VAT reduction to prices, starting in the week before the tax reduction. On average, German supermarket prices decreased by roughly 1.3%, implying that about 70% of the VAT reduction were passed on to consumers. Supermarket prices started to increase again when the VAT reduction ended, albeit rather slowly.

We also investigate how tax incidence differs across different types of products. Our findings suggest that the pass-through is stronger for goods subject to the reduced VAT rate, which mainly includes food and medical supplies. Moreover, our data and the retail market setting we consider are particularly well suited to study the role of vertical market structure for the pass-through of the VAT because our dataset includes both private label products, where production is either vertically integrated or at least suppliers do not have their own brand, and products of independent suppliers marketed under the suppliers' brand names. So far, only few studies have analyzed the link between market structure and tax incidence empirically.⁴ We find that the VAT pass-through is higher for private label products. This is consistent with models where price markups cushion cost shocks (Hong & Li, 2017). Our results are also consistent with menu cost models (Levy et al., 1997) because the cost of changing prices is higher for independent brands compared to private label products.

To the best of our knowledge, there are only two studies which provide empirical evidence on the pass-through of temporary VAT rate cuts to consumer prices. Crossley et al. (2014) analyze the VAT reduction of 2.5 percentage points for 13 months in the United Kingdom during the 2008/2009 financial crisis. The authors compare monthly inflation in the UK to inflation in 15 other OECD countries. Their results indicate that the tax cut was initially passed on to consumers in the form of lower prices. But prices started to increase again long before the VAT rate was raised again. Montag et al. (2020) also focus on the recent VAT cut in Germany and track the impact on fuel prices. The authors compare price trends at German and French gas stations and find that the pass-through in the case of diesel fuel is around 80%, while it is smaller for gasoline. The authors argue that drivers of automobiles with diesel engines drive more and are therefore more price sensitive. This interpretation is founded on a consumer search model. While this result is interesting and relevant in its own right, it focuses on a very specific product. According to the basket of goods in the official consumer price index (CPI) for Germany, expenditures on fuel at gas stations account for only 2.5% of all purchases of German households. In contrast, sales in the supermarket retail sector account for close to 10% of total consumption spending.⁵ The price effects and consumption adjustments following

⁴ Benzarti et al. (2020) show that the pass-through of a VAT rate hike for hairdressing services in Finland was inversely related to hairdressers' profit margins, suggesting that high cost markups may buffer tax shocks. There is also evidence that the pass-through of excise taxes on alcohol (Hindriks & Serse, 2019) cigarettes (Harding et al., 2012), and fuel (Doyle Jr. & Samphantharak, 2008) is related to the intensity of spatial competition between retailers.

⁵ We obtain this number by dividing the revenue in German supermarket retail by private consumption spending. The data are taken from *Gesellschaft für Konsumforschung* and the German Federal Statistical Office and refer to the year 2018.

a temporary VAT cut on electricity consumption in Belgium are studied in Hindriks and Serse (2020). The VAT cut in 2014 was intended (and communicated) to be a permanent change but was revoked by a different government in the year afterward. Similarly, Benzarti et al. (2020) study the price effects of a VAT rate cut on hair-dressing services in Finland that was announced to be permanent, but repealed five years later. Given that these reforms had no strict expiry date at the time of their implementation, the reforms cannot be counted as a temporary VAT cut in the sense of this paper.

Our study is also related to the literature on the price effects of sales tax holidays, i.e., temporary exemptions of specific consumption goods, such as clothes or school supplies, from state sales taxes in the USA. Although these tax holidays are usually limited to just a few days, previous studies have documented an almost full pass-through of temporary sales tax exemptions to sales prices (Harper et al., 2003) or even an over-shifting for some goods (Cole, 2009).

Moreover, the results of our study feed into the discussion about the effectiveness of ‘unconventional fiscal policies’ (Feldstein, 2002) and the extent to which inflation expectations of households can be affected by fiscal policy (D’Acunto et al., 2018)—an idea that has gained traction when the zero lower interest rate bound and high public debt burdens started limiting the scope of monetary and fiscal policy. Since our findings show that consumers can expect (temporary) VAT rate changes to have significant price effects, the mere announcement of a VAT rate change may alter inflation expectations and lead to an adjustment of private consumption.

Finally, our paper is related to the literature on pass-through of non-tax cost shocks, in particular exchange rate and commodity price shocks (Gopinath & Itskhoki, 2010; Hellerstein & Villas-Boas, 2010; Hong & Li, 2017). Our results regarding the role of vertical market structure for tax incidence are consistent with patterns found in this literature.

The rest of the paper is structured as follows: Sect. 2 provides background information about the situation in German and Austria during the Corona pandemic and the (economic) policy responses in both countries. Section 3 describes our data and presents some descriptive evidence on the pass-through of the VAT cut. In Sect. 4, we explain why we think that Austrian supermarket prices constitute a suitable counterfactual for supermarket prices in Germany. In Sect. 5, we estimate the pass-through of the temporary VAT rate cut and discuss our findings. In Sect. 6, we assess whether the pass-through varies across different product groups. Section 7 analyzes the link between vertical integration and VAT pass-through. Section 8 concludes.

2 The Corona pandemic in Germany and Austria and (economic) policy responses

How were Germany and Austria affected by the pandemic and what were their policy responses? What started with few individual cases and locally restricted clusters of COVID-19 outbreaks in January and February 2020 turned into rapidly increasing infection numbers in early March in all parts of Germany and Austria, with COVID-related deaths trailing by a few days (see Figs. 1 and 2). In response

to this ‘first wave’ of the pandemic, which occurred simultaneously in Germany and Austria, both governments implemented a range of containment measures in mid-March.⁶ These included restrictions on social interactions, prohibitions of public events, as well as the closure of many businesses and venues where people gather, including restaurants, bars, hotels and other lodging places, cinemas, theaters, libraries, museums, and most retail stores. An exemption was made for stores and businesses providing essential goods and services, especially supermarkets, drug stores, pharmacies, and medical service providers. These measures were gradually lifted when the number of infections began to decrease in mid-April: restrictions on social contacts were relaxed and non-essential retail was allowed to re-open subject to hygiene requirements.

Infection numbers started to increase again in fall and accelerated in October, especially in Austria. Both Germany and Austria went into a partial shutdown again in the beginning of November (‘lockdown light’) with night-time curfews, domestic tourism banned, and cultural places such as theaters closed. Restaurants and bars were only allowed to offer take-away food. In mid-November, the partial lockdown turned into a ‘hard lockdown’ in Austria with nation-wide curfews extended to the whole day and non-essential retail closed entirely. Germany went back into a hard lockdown only a few weeks later in mid-December. Like in March and April, essential retail such as supermarkets and pharmacies were exempted from this rule and remained open for customers at all times in both countries.

Figure 3 indicates the implications of these policies on public life. The figure shows how the number of visits to retail stores and recreational facilities (top left panel), grocery stores and pharmacies (top right panel), residential facilities (middle left panel), peoples’ workplaces (middle right panel), transit stations (bottom left panel), and parks (bottom right panel) have developed in Germany (blue lines) and Austria (orange lines) between February 2020 and March 2021. During the lockdowns in January and December 2020, public life was severely restricted. For example, visits to retail stores and recreational facilities decreased by 60–80% and workplace visits by close to 60%. In contrast, time spent at home increased by about 20%. Note that the development of people’s mobility was very similar in both countries, which is important for our identification strategy.

The pandemic did not only have severe implications on peoples’ social lives, but also brought about significant losses of economic output in both countries, particularly in industries such as hospitality, tourism, and the entertainment sector. Both governments took various measures to stabilize aggregate demand and to support firms, employees, and freelancers (see Tables 4 and 5 of Appendix B for a timeline of Corona related events and (economic) policy responses).⁷ The economic policy responses in the two countries were very similar: at first, the governments of both

⁶ A detailed timeline of the main COVID-related events and policy measures taken in Germany and Austria can be found in Tables 4 and 5 of Appendix B.

⁷ Detailed accounts of the stimulus measures are provided by Dorn et al. (2020) for Germany and Baumgartner et al. (2020) for Austria. See also the IMF database on fiscal policy responses to COVID 19: <https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#A>.

Germany and Austria adopted several so-called emergency aid measures (in German: *Soforthilfen*) which aimed at providing ailing firms and self-employed persons with liquidity. These measures included loan provisions, credit guarantees, and fixed cost subsidies. Financial support for firms was complemented by income tax deferrals and increased loss-carrybacks. Similarly, social security payments could be deferred or paid in installments. Another key support measure taken by both countries was to ease access to the short-term furlough schemes.⁸ These emergency aid measures were implemented in March (Germany) and April (Austria) of 2020, respectively. In June 2020, the governments of both countries passed extensive fiscal stimulus packages, which included a series of measures aimed at increasing disposable household incomes. For instance, households with children received one-time cash payouts in both countries: 360 euro per child in Austria and 300 euro in Germany. In addition, both countries temporarily reduced the VAT for restaurant services to 5%.⁹ A unique feature of the German stimulus package was a temporary economy-wide reduction of VAT rates. Between July 1 and December 31, 2020, the standard VAT rate was reduced from 19 to 16% and the reduced rate, which applies broadly to ‘basic goods and foodstuff,’ was reduced from 7 to 5%. Austria, in contrast, did not implement an economy-wide VAT cut.

Thus, taken together, both countries moved closely together in terms of the timing of infection waves as well as measures for prevention and stimulus. Supermarkets were allowed to remain open at all times and subject to the same hygiene measures, i.e., they were operating under the same conditions in both countries. Manufacturing firms received government support in the form of liquidity provisions and were allowed to keep their production running. Moreover, household incomes were stabilized in both countries, mostly through a generous expansion of short-time furlough schemes with roughly equally high replacement rates. The main difference in terms of economic policy responses was the economy-wide reduction of VAT rates in Germany, a measure that was not adopted in Austria.

3 Data and descriptive statistics

To identify the impact of the temporary VAT reduction, we exploit daily price data from the online shops of REWE in Germany and Billa in Austria, which is also part of the REWE group. In 2019, the REWE group was the second largest supermarket chain in Germany in terms of market share (17.8%) and the largest one in Austria

⁸ These programs allow employers to reduce their employees’ working hours without laying them off. Employees in Germany receive a share of the net loss in income incurred of at least 60 and 67%, respectively, in the case of an employee without children and with at least one child. These allowance rates increase over time to 80 and 87%, respectively, after a period of six months. Austria has a very similar program that grants allowances of at least 80% of the previous net salary and up to 90% for smaller salaries under the current legislation until the end of March 2021.

⁹ Before the reduction, the VAT rate for restaurants was 19% in Germany and 20% (for food) and 10% (for drinks), respectively, in Austria.

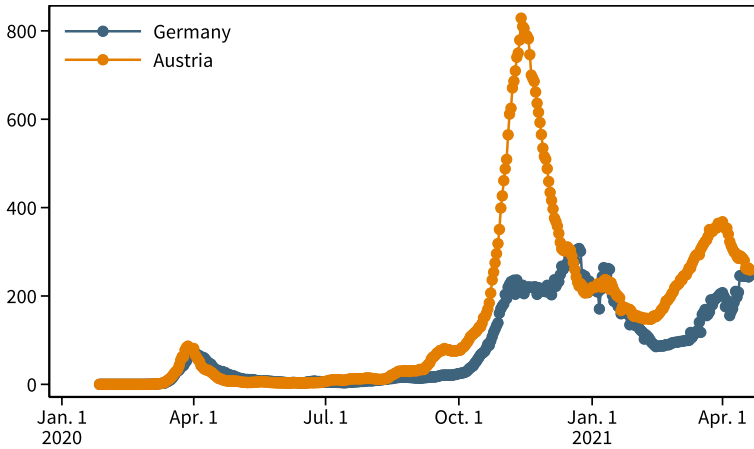


Fig. 1 Development of COVID-19 Infections in Germany and Austria. *Notes* The figure shows the one-week moving averages of the daily number of COVID-19 infections per one million inhabitants Data source: Our World in Data, COVID-19 Dataset, Series: new_cases_smoothed_per_million

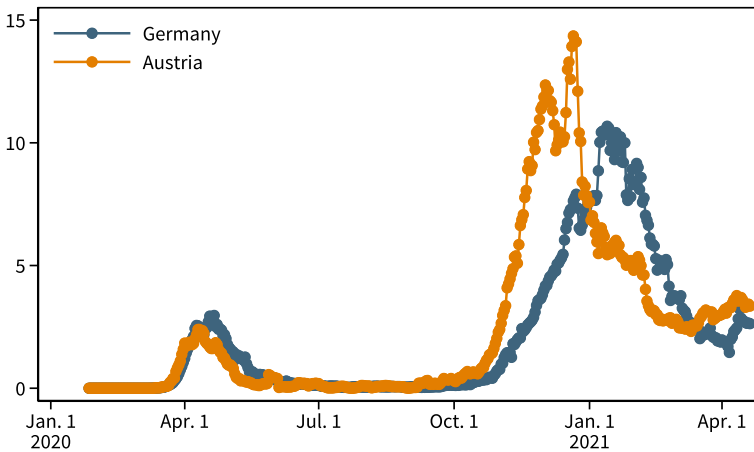


Fig. 2 Dynamics of Deaths Due to COVID-19 in Germany and Austria. *Notes* The figure shows the one-week moving averages of the daily number COVID-19-related deaths per one million inhabitants Data source: Our World in Data, COVID-19 Dataset, Series: new_deaths_smoothed_per_million

(34.1%).¹⁰ We provide more background information about the two supermarket chains and the retail markets in the two countries in Appendix A.

An automatized webscraping algorithm was used to collect the relevant product information every day from both the REWE and Billa online shop, including the product ID, the product name, the brand name, the current retail product price, as well as the product category (e.g., ‘staple food,’ ‘fruit and vegetables,’ ‘beverages,’ and ‘cosmetics’), sub-category (e.g., ‘baking ingredients,’ ‘fruit,’ ‘soft drinks,’ and ‘body care products’), and sub-sub-category (e.g., ‘flour,’ ‘apples,’ ‘lemonade,’ and ‘deodorant’).

¹⁰ Source: The Nielsen Company.

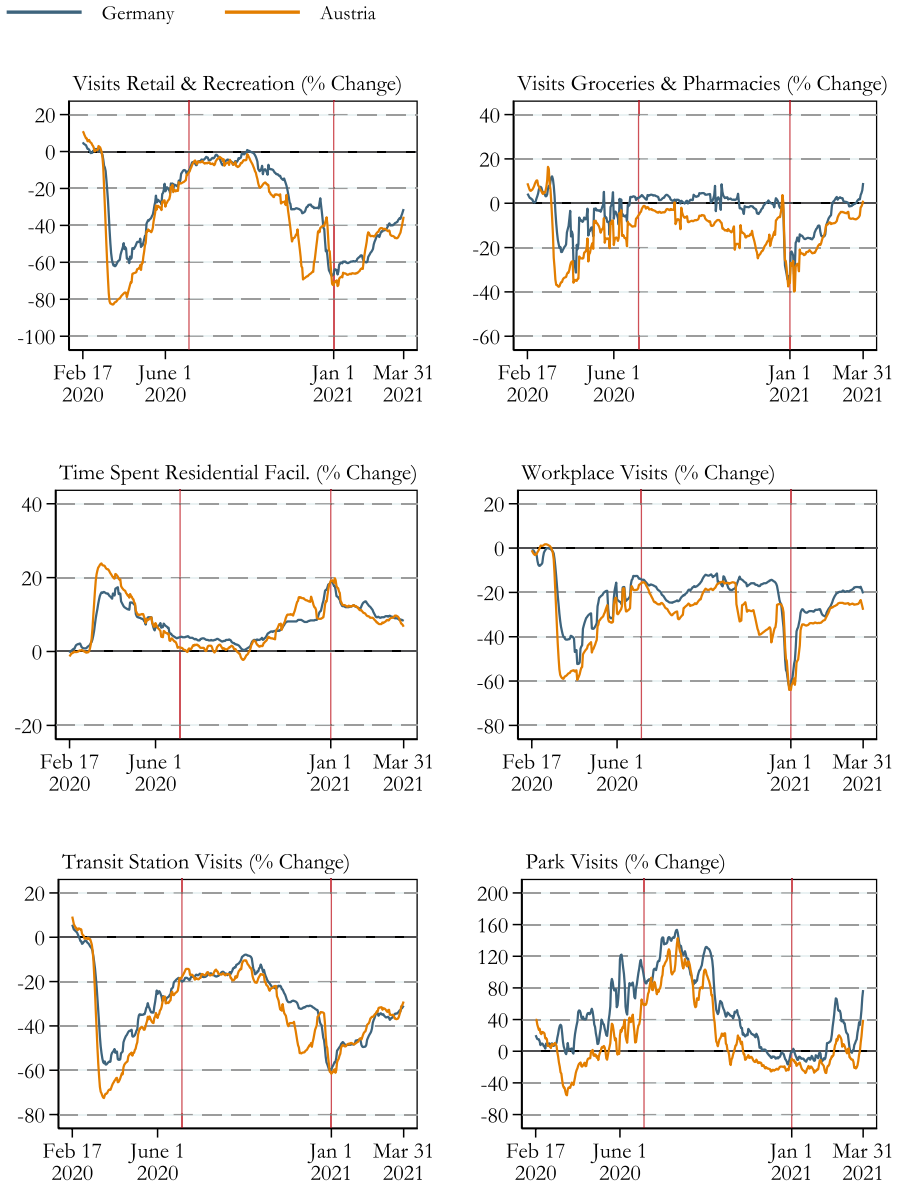


Fig. 3 Mobility in Times of COVID—Google Mobility Indicators. *Notes* The figure shows the change in the number of visits to/time spent in retail stores and recreational facilities (top left panel), grocery stores and pharmacies (top right panel), residential facilities (middle left panel), peoples' workplaces (middle right panel), transit stations (bottom left panel), and parks (bottom right panel) in Germany (blue lines) and Austria (orange lines) between February 2020 and March 2021. The baseline value is the median value during the five week period from January 3 until February 6, 2020. Data source: Google COVID-19 Community Mobility Reports (Color figure online)

In the case of REWE, we collected up to 190,000 product prices per day, starting in September 2019. Data from Billa are available since June 4, 2020, that is, the first day after the announcement of the VAT reduction. The data cover around 9500 products per day.¹¹ Note that the assortment of products that is available to customers in the REWE online shop exceeds the set of products available in ‘physical’ stores. The assortment in physical stores is mostly restricted to food, beverages, and hygiene products. The online shop, in contrast, also feature a limited number of clothes, various electronic devices, as well as some kitchen and garden utensils. In contrast, for Billa, the assortment of products available in the online shop resembles that of physical stores. All prices already include the VAT.

The online shops of both REWE and Billa allow customers to choose between two options. Customers can either have the products delivered to their homes or pick up the goods they ordered at the nearest store, where the supermarket employees will prepare them for pick-up, ready-packed. Both REWE and Billa charge a fee for home delivery, and there is a minimum order value for home deliveries of 50 euro. In contrast, pick-up orders are free of charge. For products offered both online and in physical stores, online prices are identical to those in physical stores, and they do not vary across stores.

REWE started its home delivery service in 2012, Billa in 2015. In each of the two countries, there is only one other supermarket chain that also offers its complete product range online. In Germany, this is Edeka, and in Austria, this is SPAR. For those two supermarket chains as well, the prices in the online shops are identical to those in brick-and-mortar stores.

Note that the definition of product categories varies between REWE and Billa.¹² To harmonize the product categorization, we assign each REWE and Billa product to one out of 186 ‘Classification of Individual Consumption According to Purpose’ (COICOP) product classes.¹³ Many countries, including the EU member states, publish disaggregate price data for single COICOP product classes as well as weights with which these classes are reflected in national consumer price indexes (CPI). The application of COICOP classes thus allows us to use CPI weights in our analysis, so that we can assess how the VAT change affects a representative consumer.

The fact that the number of products available at REWE exceeds the number of products available at Billa by far may raise concerns about the suitability of the Billa product set as a counterfactual for the product set of REWE. To harmonize the product sets, we exclude all product categories and product sub-categories for which there is no equivalent at the online shop of the other supermarket chain. The

¹¹ We started collecting price data from REWE for a different purpose, which is why our sample period begins long before the announcement of the temporary VAT reduction.

¹² For example, in the Billa online shop, ‘tea, coffee, and cocoa’ is a sub-category of ‘beverages.’ In the REWE online shop, ‘tea, coffee, and cocoa’ is a main category. The opposite is true for ‘bread and baked goods.’ In other cases, the collection of goods belonging to the same sub-category or sub-subcategory differs between the online shops.

¹³ COICOP is published by the UN Department of Economic and Social Affairs and serves as the international reference classification of household expenditure. It is an integral part of the System of National Accounts and used for many statistical purposes such as, for instance, the establishment of weights for the computation of consumer price indexes and the calculation of purchasing power parities.

resulting harmonized product set comprises 55,337 products from REWE and 8504 products from Billa.¹⁴

Table 3 of Appendix A shows descriptive statistics for our harmonized set of REWE and Billa products. The table shows the number of REWE and Billa products for the different COICOP product classes covered by our data as well as the average product price per class. In addition, the table shows how much of her disposable income a representative consumer spends on each product class (column *CPI weight*) and indicates which products are taxed at the reduced VAT rate (column *Reduced VAT rate*). ‘Food and non-alcoholic beverages’ is by far the largest product category in both supermarket chains. About 56% of REWE products and 75% of Billa products fall into this category. The second largest product category is ‘Alcoholic beverages,’ followed by ‘Personal care products’ and ‘Furnishing, household equipment and routine maintenance,’ which mainly comprises non-durable household goods. Average product prices are very similar at REWE and Billa. All in all, about 20% of German households’ total expenditure is spent on the products included in our dataset.

The distribution of retail prices is shown in Fig. 4. Separate density estimates are provided for products from the REWE and Billa online shop, covering only those products included in the harmonized product sample. Product prices are from the first week of June. While most items in both shops cost between one and five euro, the assortment of REWE also comprises higher priced products. This is also reflected in the average product price: while the average product costs about four euro at Billa, it is eleven euro at REWE.

The Corona pandemic has led to a significant shift toward online shopping.¹⁵ In Germany, the share of retail spending made online increased from 10.1% in 2018 to 14.7% in 2021 (cf. Table 1). In Austria, this share has increased from 7.9% to 13.0% over the same period. While this trend is also observable when it comes to online grocery shopping, the share of grocery spending made online is still very small. In Germany, only 1.2% of all grocery spending was made online in 2018 and 2.7% in 2021. In Austria, the share of online grocery spending was 2.6% in 2021 and, thus, of similar magnitude.¹⁶

Figure 5 gives a first impression of the price dynamics around the announcement and implementation day of the VAT reduction. The figure shows the development of the REWE and Billa product price index over time (base period: first week of June 2020).¹⁷ It reveals that right at the time when the VAT rate cut in Germany became effective, the (relative) prices in German and Austrian supermarkets drifted

¹⁴ The fact that the number of REWE products still exceeds the number of Billa products is due to the larger number of brands and product varieties offered by REWE. For example, the REWE online shop features 185 types of flour, 416 types of bread, and 462 types of cereals. At Billa, there are 22 types of flour, 106 types of bread, and 99 types of cereals.

¹⁵ For the USA, Agrawal and Shybalina (2023) show that this shift to online shopping led to a redistribution of sales tax revenue from urban centers to rural areas.

¹⁶ Unfortunately, data on the online share of grocery spending for Austria are not available for earlier years.

¹⁷ The REWE (Billa) price index represents a weighted average of the price indexes of the single REWE (Billa) products. In both cases we use the CPI weights for Germany.

apart. Between July and mid-October 2020, the German supermarket price index was roughly one percentage point lower than the Austrian price index. Prices started converging in November, but drifted apart again at the end of 2020. After the German VAT rate cut was reversed on January 1, 2021, the German supermarket price index remains lower than the Austrian index. This trend persists until the end of our observation period in March 2021.

Note that in the weeks before and after the VAT reduction, the price trends in Austria are close to the German trend, suggesting that Austrian supermarket prices indeed represent a suitable counterfactual for the German prices. We will discuss this further in the next section.

4 Conditions for causal inference

In our empirical approach, we use Austrian supermarket prices as counterfactuals for prices in Germany. I.e., the Austrian prices show us how supermarket prices in Germany would have developed without the temporary VAT reduction. For our identification strategy to be valid, the following conditions must hold:

1. The consequences of the COVID-19 pandemic and the (economic) policy responses to it were similar in Germany and Austria.
2. Before the VAT reform, the development of supermarket prices in Germany resembled the price development in Austria.

The first condition requires that no other factor besides the temporary VAT reduction in Germany has affected supermarket retail prices in Germany and Austria differently. This pertains in particular to the consequences of the COVID-19 pandemic as well as to the measures the German and Austrian government have taken to contain the spread of the virus and to dampen the economic slump. As explained in Sect. 2, we believe that Austrian supermarket prices represent a particularly suitable counterfactual for our analysis for at least three reasons. First, the dynamics of the Corona pandemic as well as the measures implemented by the governments to contain the spread of the coronavirus have been comparable in Germany and Austria. Second, the Austrian government adopted a fiscal stimulus package to combat the economic consequences of the Corona pandemic that was very similar with regard to the measures and (relative) magnitude to the stimulus package implemented in Germany. However, Austria did not adopt a general VAT rate cut.¹⁸ Third, the Austrian stimulus package was announced less than three weeks after the German one.

The second condition for causal inference requires that without ‘treatment’ (i.e., the temporary VAT reduction in Germany), the development of the outcome variable (i.e., supermarket prices) would have been identical in the treatment and control

¹⁸ Austria only reduced the VAT rate for hotels, restaurants, and certain cultural institutions like theaters, museums or natural parks. Germany also provided a targeted VAT cut for food served in restaurants and hotels, where the reduced rather than the standard rate was applied as from July 1, 2020. This was in addition to the general VAT cut which is the focus of our analysis.

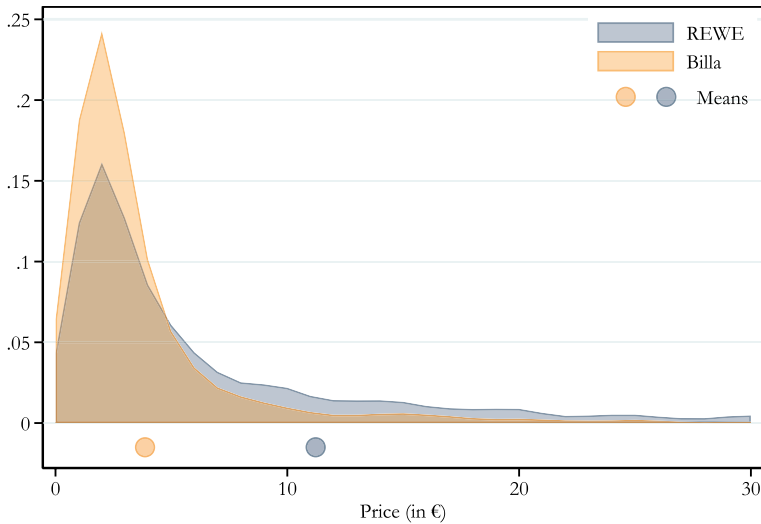


Fig. 4 Comparison of REWE and Billa prices—Harmonized product set. *Notes* The density plot is based on price data collected from the REWE and Billa online shops in the first week of June which serves as the base period in our analysis

Table 1 Online shares in retail and grocery spending in Germany and Austria

Year	Online share retail spending		Online share grocery spending	
	Germany (%)	Austria (%)	Germany (%)	Austria (%)
2017	9.5	7.9	1.1	–
2018	10.1	8.7	1.2	–
2019	10.8	9.6	1.4	–
2020	12.6	11.0	2.0	–
2021	14.7	13.0	2.7	2.6
2022	13.4	14.0	2.9	–

The figures indicate the share of retail (left panel) and grocery (right panel) spending by consumers in Germany and Austria that is done online to total retail and grocery spending, respectively. Data for Germany come from the German Retail Association (*Handelsverband Deutschland*), and data for Austria come from the Austrian Retail Association (*Handelsverband Österreich*). For Austria, information about the share of online grocery spending is only available for the year 2021

group (common trend assumption). We only started collecting price data from Austrian Billa supermarkets the day after the German VAT reform was announced. Due to that, our pre-treatment period only covers three weeks, which is too short for a meaningful comparison of pre-treatment trends and a credible test for the validity of the common trend assumption. Moreover, during those three pre-reform weeks, prices may have already adjusted in anticipation of the reform. In this subsection,

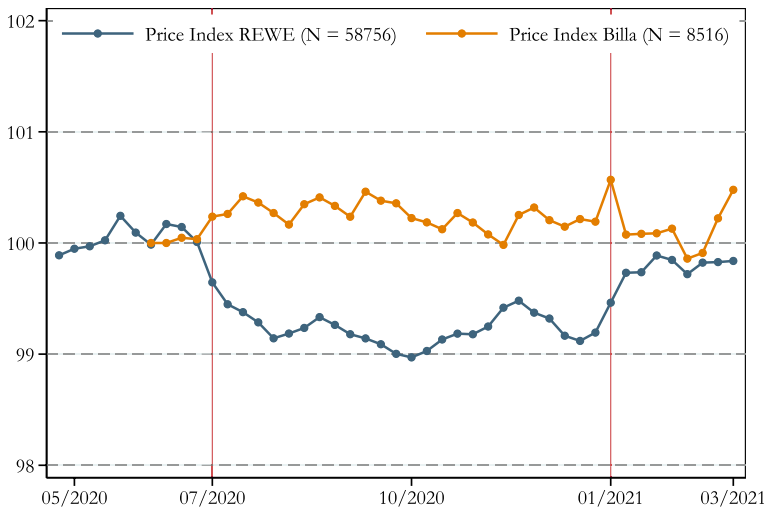


Fig. 5 Comparison of Price Indexes across REWE and Billa. *Notes* The figure shows the development of the weekly price indexes for REWE and Billa (base period: first week of June 2020). The REWE (Billa) price index represents an weighted average of the price indexes of the single REWE (Billa) products. German CPI weights are used. The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020) and the second solid vertical line indicates the day of the reversal of the VAT rate cut (January 1, 2021)

we provide some suggestive evidence for the absence of anticipation effects and the suitability of Austrian supermarkets as a control group.

First, we take advantage of the fact that we already started collecting REWE prices in September 2019 and take a closer look at the price dynamics at REWE supermarkets over the one and a half years between September 2019 and March 2021. Figure 6 shows the weekly absolute change of the REWE price index. The figure reveals that price movements already occurred in the months before the VAT rate was cut. Compared to the fluctuations we observe at around the time of the VAT reduction and its expiration, though, the price movements are small and show no clear direction. The only statistically significant change in the REWE price index before the VAT reduction occurred at the beginning of May 2020, when prices increased by, on average, 15%. However, since the VAT reduction was only announced in June, the price increase cannot be driven by anticipation effects. Also, only one week after the price increase, prices decreased again to roughly the same extent. Over the time period considered here, by far the most distinct price adjustments occur in the week in which the VAT reduction became effective as well as the week in which the VAT rate cut was repealed.

Second, we compare the development of the price indexes of different product groups across Germany and Austria using official price statistics from Eurostat (products exempt from VAT are excluded). Figure 7 shows the weighted average realizations of the monthly price indexes since January 2017 for the 168 COICOP

product groups which are subject to VAT.¹⁹ In Fig. 8, we restrict our attention to product groups that make up the largest fraction of the REWE and Billa assortments—food and non-alcoholic beverages, alcoholic beverages and tobacco, and hygiene and cosmetic products. Before the temporary VAT reduction, prices in Germany and Austria have developed very similarly. Differences between the price indexes in Germany and Austria before the VAT reduction were only of minor size and not statistically significant, as Figs. 25 and 26 of Appendix B demonstrate. This is also true for the months before the temporary VAT rate change, at least until June. But even in June, there are more price movements, but without clear direction, suggesting that prices in Germany did not change in anticipation of the VAT rate cut. This suggests that Austrian supermarket prices represent a credible counterfactual for supermarket prices in Germany.

5 Price effects of the temporary VAT rate change: baseline specification

In this section, we estimate the price response to the temporary VAT reduction using regression analysis. Section 5.1 describes the empirical approach, and Sect. 5.2 shows the results. In Sect. 5.3, we test the robustness of our findings by modifying our empirical specification in several ways.

5.1 Estimation Strategy

To estimate the magnitude of the temporary VAT reduction's price effect and to test its significance, we use an event study approach. This approach also allows us to see how the price effect evolves over time and provides an easy and intuitive way to visualize the impact of the temporary VAT change (Schmidheiny & Sieglöcher, 2020). Specifically, we estimate the following empirical model:

$$p_{i,w} = \sum_{j=-3} \beta_j \times b_{i,w}^j + \mu_i + \theta_w \times \text{COICOP}_{4\text{-digit}} + \varepsilon_{i,w} \quad (1)$$

Index i refers to the individual product, index w to the week of the observation, and superscript j denotes the number of weeks until/after the VAT reduction. The dependent variable, $p_{i,w}$, is the average price index of product i in week w (base period: first week of June).²⁰ All prices include the VAT. $b_{i,w}^j$ is our event study indicator. We estimate two specifications of Eq. (1) which differ with regard to the definitions of our event study indicators. In the first specification, the $b_{i,w}^j$ are dummy variables that are equal to one j weeks before/after the VAT reduction if product i is a REWE product and zero if it is offered by Billa. This approach provides estimates

¹⁹ We use the COICOP weights used to calculate the Consumer Price Index for Germany to compute weighted averages. The weights can be found here: <https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Verbraucherpreisindex/FAQ/anteil-gueter-warenkorb.html>.

²⁰ We compute average weekly price indexes because prices hardly vary within a week.

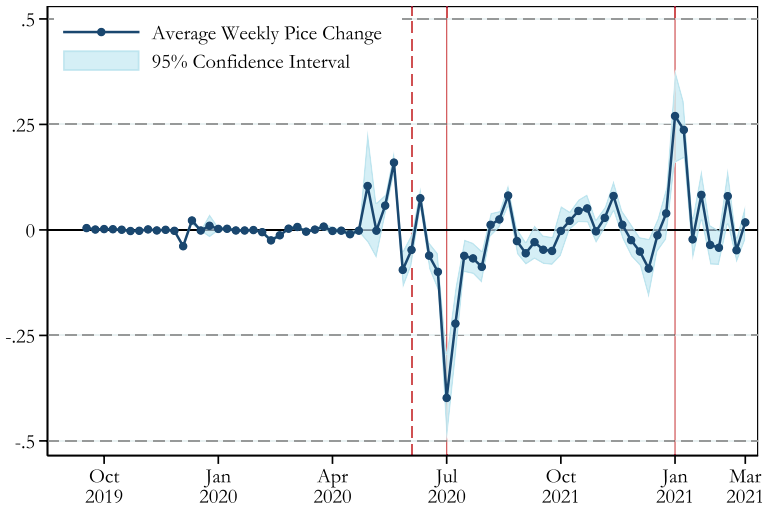


Fig. 6 Average weekly change in REWE product prices. *Notes* The figure shows the average weekly prices absolute change in the price index for REWE products along with the 95% confidence interval. The price index represents a weighted average of the price indexes of the single REWE products. German CPI weights are used. The price index is computed based on the harmonized product set covering up to 59,885 REWE products. The dashed vertical line indicates the day of the announcement of the temporary VAT reduction (June 3, 2020), the first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the reversal of the VAT rate cut (January 1, 2021)

for week-specific price changes (in percent) in response to the VAT rate changes. However, these estimates reflect average price changes. They do not take into account that some goods are subject to the normal VAT rate and others are subject to the reduced VAT rate, and that the size of the VAT cut was different for the two product groups. In addition, we would like to know what share of the VAT rate cut is passed on to prices. This is what the second specification delivers. In the second specification, $b'_{i,w}$ measures the change in the VAT burden relative to product i 's after-VAT price:

$$b_{i,w} = \frac{1 + t}{1 + \tilde{t}} - 1$$

t is the original VAT rate and \tilde{t} is the temporarily reduced VAT rate. In this specification, the event study indicators measure by how much (in percent) the price (which includes the VAT) of product i would have fallen after the VAT cut in case of a full pass-through. Prices of products subject to the standard VAT rate (which was reduced from 19 to 16%) would have fallen by 2.52% and prices of products subject to the reduced VAT rate (which was reduced from 7 to 5%) would have fallen by 1.87%. The coefficient estimates of the event study indicators measure the actual

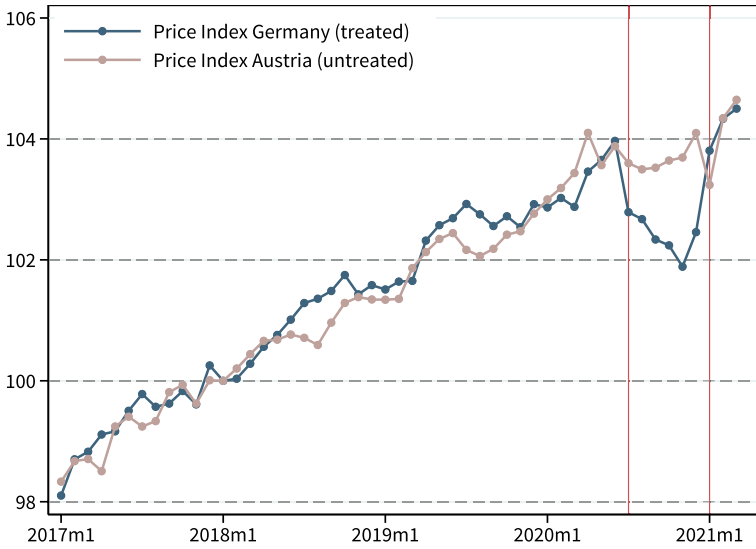


Fig. 7 Price development in Germany and Austria since 2017. *Notes* The figure shows the weighted average monthly price indexes for 168 product groups for Germany and Austria (base period: January 2018). German CPI weights are used for both Germany and Austria. The first solid vertical line indicates the month of the VAT rate cut (July 2020), and the second solid vertical line indicates the month of the reversal of the VAT rate cut (January 2021). Data source: Eurostat

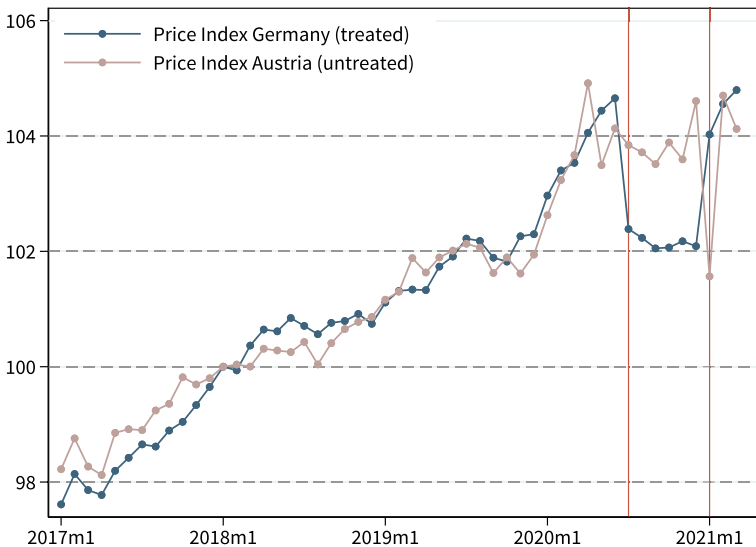


Fig. 8 Price development for selected product groups in Germany and Austria since 2017. *Notes* The figure shows the weighted average monthly price indexes for food and non-alcoholic beverages, alcoholic beverages and tobacco, and hygiene and cosmetic products for Germany and Austria (base period: January 2018). German CPI weights are used for both Germany and Austria. The first solid vertical line indicates the month of the VAT rate cut (July 2020), and the second solid vertical line indicates the month of the reversal of the VAT rate cut (January 2021). Data source: Eurostat

pass-through rate of the temporary VAT reduction. I.e., they tell us what share of the VAT rate change was passed on to consumers.²¹

θ_w is a week-fixed effect, which we interact with a set of dummy variables indicating to which COICOP product class (corresponding to the 4-digit level of the COICOP classification) a product belongs, allowing us to control for heterogeneous price trends across product classes. Also, the inclusion of these interaction terms implies that our identification is based on variation in product prices across REWE and Billa within product classes. μ_i is a product-fixed effect that accounts for time-invariant product characteristics, and $\varepsilon_{i,w}$ is the residual error term.²² Standard errors are clustered at the 4-digit COICOP product class times country level, yielding 47 clusters.²³ Our event window covers 43 weeks, that is, three and a half weeks before the VAT reduction, 27 weeks during which the VAT rate cut was effective, and twelve and a half weeks after the VAT rate cut was reversed. Our reference period is the first week of June ($j = -4$), that is, the week in which the VAT rate cut was announced. We weight the observations using the product groups' CPI weights (cf. Table 3 of Appendix A), which allows us to assess how the representative consumer is affected by the temporary VAT change. Results for unweighted regressions are presented in Figs. 27 and 28 of Appendix B.

In Sect. 6, we analyze whether the pass-through of the temporary VAT reduction varies across different product groups. To this end, we estimate Eq. (1) separately for products taxed at the regular VAT rate and products taxed at the reduced VAT rate. In addition, we estimate the incidence of the VAT separately for food and non-alcoholic beverages, alcoholic beverages, and hygiene and cosmetic products, which represent the most important product groups in terms of the number of products. In Sect. 6, we investigate whether the pass-through is related to the vertical market structure.

5.2 Empirical results

Figure 9 plots the coefficient estimates for the first specification. As explained in the preceding section, the estimates indicate by how much product prices changed (in percent), on average, in response to the VAT change. Figure 10 shows the coefficient estimates of the second specification, where the coefficient estimates can be interpreted as pass-through rates. The shaded areas represent 95% confidence intervals.²⁴ Both figures show a significant decrease in German supermarket prices (relative to Austrian prices) in the week the VAT rate cut became effective. Shortly after, the price difference grew to roughly 1.3%, and—apart from minor

²¹ For example, a price reduction of 1.26% in response to the tax cut for goods subject to the standard VAT rate would imply a pass-through of 50%.

²² The fixed effects refer to specific products, not product categories or classes. Our baseline specification thus includes roughly 68,000 product-fixed effects.

²³ Clustering standard errors at the product class level would be justified in case similar products are exposed to similar shocks. This assumption is plausible if price developments are mainly driven by production conditions or demand-side factors.

²⁴ Table 6 of Appendix B shows the estimates in table format.

fluctuations—remained at that level until VAT rates returned to their previous level (cf. Fig. 9). Figure 10 reveals that the price decrease of 1.3% corresponds to an average pass-through rate of the VAT rate cut of roughly 70%. This implies that the temporary VAT reduction benefited both consumers and suppliers, but consumers benefited to a larger extent.

The difference between German and Austrian supermarket prices became smaller only after VAT rates returned to their original level in January 2021. Interestingly, though, prices in German supermarket retail do not fully catch up in the time period covered by our data. Even three months after the VAT rate cut was repealed, German supermarket prices were 0.5–0.6% lower than they would have been without the tax cut. Thus, there is an asymmetric reaction to the temporary VAT reduction in Germany. The price decrease in response to the VAT rate cut was roughly two times larger than the price increase following the tax rate hike.²⁵ There is anecdotal evidence according to which some large German retailers advertised that they would not immediately raise prices after the rate cut, which may have triggered more intense price competition among the large retailers.²⁶ This would imply that the asymmetry is specific to supermarket retail and cannot be generalized. Of course, whether this explains the asymmetry observed in the data is an open question.

5.3 Robustness checks

To check the robustness of our results, we modify our empirical specification in different ways. First, we re-estimate Eq. (1) using unweighted OLS regression. As illustrated in Figs. 27 and 28 of Appendix B, the coefficient estimates of the event study indicators remain virtually identical.

In a second modification, we reduce our product set in order to address the mismatch between the number of REWE and Billa products. More precisely, we restrict our analysis to ‘food and non-alcoholic beverages’ (COICOP class 01; cf. Table 3), ‘non-durable household goods’ (COICOP class 05.6.1), and ‘other appliances, articles, and products for personal care’ (i.e., hygiene & cosmetic products; COICOP class 12.1.3). The resulting sample comprises around 45,400 products, of which 38,000 are from REWE and 7400 from Billa. Figure 24 of Appendix B compares the distribution of prices of REWE and Billa products for the reduced product set. The results of the event study estimations are presented in Figs. 29 and 30 of Appendix B. Again, we find that our estimates are hardly affected.

Finally, we check the robustness of our findings by means of placebo test. To this end, we move the treatment date 6, 10, and 14 weeks back, pretending that the temporary VAT rate cut took place on August 12, September 9, and October 7, respectively. In each case, we re-estimate Eq. (1) for an event window covering four weeks

²⁵ This result is the opposite of what Benzarti et al. (2020) find. The authors exploit a VAT rate reduction for hairdressing services in Finland that was communicated to be permanent, but eventually repealed five years later. Their findings suggest that the price change in response to the VAT rate hike was two times larger than the price change following the VAT rate cut.

²⁶ <https://www.businessinsider.de/wirtschaft/mehrwertsteuer-supermarkt-branche-aldi-lidl-misstrauen-b/>.

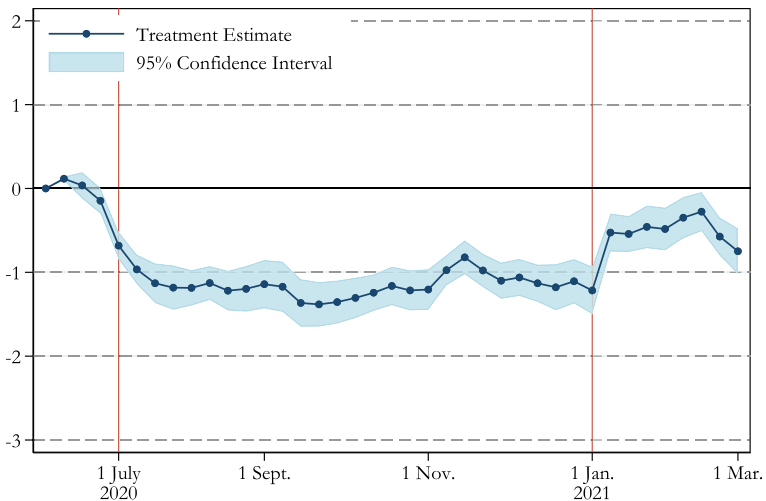


Fig. 9 Results of event study analysis: impact of the VAT rate cut on prices. *Notes* The figure shows the coefficient estimates for the event dummies along with the 95% confidence intervals. The y-axis indicates the price change in percent. The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 63,841, and the number of clusters is 47

before and four weeks after the placebo treatment date. That way, we make sure that the actual treatment dates (i.e., the day of the VAT rate cut and hike) are not included in our event window. The results are illustrated in Fig. 31 of Appendix B. As can be seen, the estimates of the pass-through rate are very close to zero throughout the whole event window. Only few estimates turn out to be significantly different from zero. This, however, is a consequence of narrow confidence intervals rather than economically relevant estimates.

6 Price effects for different product groups

In this section, we look at the heterogeneity in tax shifting across product groups. To this end, we estimate separate price effects for (i) products taxed at the regular VAT rate vs. products taxed at the reduced rate as well as (ii) the largest product groups included in our sample, i.e., food and non-alcoholic beverages, alcoholic beverages, and cosmetic and hygiene products.

6.1 Results for products taxed at the regular versus reduced rate

Benedek et al. (2020) study the effects of (permanent) VAT rate changes on consumer prices in Eurozone countries based on a sample of 70 commodity groups. The

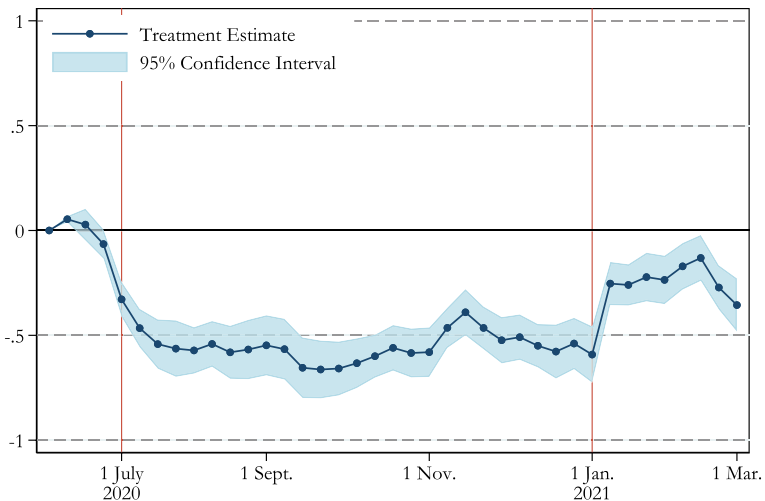


Fig. 10 Results of event study analysis: pass-through of the VAT rate cut to prices. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 63,841, and the number of clusters is 47

authors detect notable differences in pass-through rates for products taxed at standard VAT rates and those taxed at reduced rates. In the former case, the estimated pass-through is close to 80%; in contrast, for products taxed at a reduced rate, the pass-through is only about 30% and not even statistically significant.

We test whether we detect a similar pattern when it comes to the temporary VAT reduction in Germany and estimate Eq. (1) separately for products taxed at the regular rate—which was reduced from 19 to 16%—and products taxed at the reduced rate, which was lowered from 7 to 5%. Figure 11 illustrates the results for the former product group, Fig. 12 for the latter one. Our results are basically opposite to those reported by Benedek et al. (2020): We find that the pass-through rate is smaller for regular taxed products than for products taxed at the reduced rate. For the former product group, the pass-through of the temporary VAT reduction is roughly 50%, implying that half of the reduction of the VAT burden is passed on to consumers. For products taxed at the reduced rate, the pass-through rate is, on average, around 75%. These results are in line with standard tax incidence theory: The reduced rate mainly applies to products of daily use and necessities such as foodstuff, beverages, and medical supplies. Arguably, these products are characterized by a small demand elasticity, which is why one would expect the VAT pass-through to be large.

6.2 Results for different product groups

Figures 13, 14 and 15 show the pass-through of the VAT rate changes separately for the three major product groups from the assortment of REWE and Billa products (cf. Table 3)—food and non-alcoholic beverages (Fig. 13), alcoholic beverages and tobacco (Fig. 14), and cosmetic and hygiene products (Fig. 15).²⁷ The figures show substantial variation in pass-through rates. For food and non-alcoholic beverages, the pass-through of the temporary VAT reduction is as high as 80%, suggesting that the bulk of the tax relief benefited consumers. Arguably, this finding is intuitive, as the demand for products belonging to this group should be rather inelastic. For alcoholic beverages and tobacco as well as cosmetic and hygiene products, the pass-through is notably smaller, with average pass-through rates of 20–30%. Another explanation for the different pass-through rates across the product groups could be related to their durability. Due to the temporary nature of the VAT rate cut, consumers may have purchased tobacco and cosmetic products in stock, leading to an increase in the demand for these goods. Food, in contrast, can be bought in stock only to a limited extent, as it expires more quickly.

7 The role of market structure: vertical integration

7.1 Private label versus brand products

One potential source of heterogeneity of pass-through is that different products are supplied under different market structures. How does market structure affect tax incidence?²⁸ Our data and the retail market setting we consider allow us to shed some light on the role of a particular aspect of market structure, which is vertical integration. To be precise, we do not directly observe vertical integration, but we can distinguish between private label products and independent brands. In the following, we interpret differences in shifting between these product groups as a result of differences in vertical integration. But one should note that these differences could also simply be driven by the fact that supermarkets have different pricing strategies for these two product types, irrespective of the underlying market structure. We emphasize the market structure interpretation because the importance of vertical integration has been highlighted by empirical studies on the impact of non-tax cost

²⁷ Note that we compute White-robust standard errors instead of clustering standard errors at the 4-digit product class level since the number of clusters would be very small. I.e., the product group ‘food and non-alcoholic beverages’ comprises 22 4-digit product classes, the product group ‘alcoholic beverages and tobacco’ seven 4-digit product classes, and the product group ‘cosmetic and hygiene products’ five 4-digit product classes.

²⁸ From a theoretical perspective, the implications of market structures for tax incidence are generally ambiguous and often depend on the curvature of demand and cost functions as well as the particular market setting. For instance, more market power in oligopolistic markets may lead to more or less shifting of a consumption tax (Weyl & Fabinger, 2013). In an earlier version of this paper (Fuest et al., 2021), we analyze consumption tax incidence in a love of variety model and show that tax shifting to consumers may be higher or lower in product groups with more varieties, depending on the properties of marginal cost and demand functions.

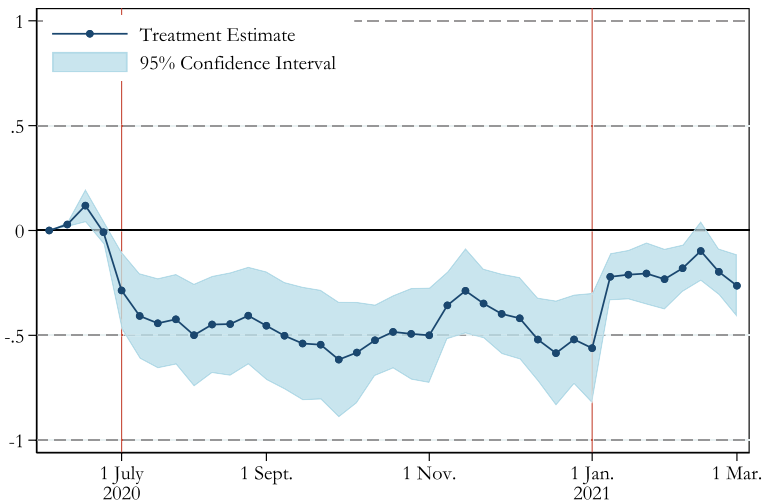


Fig. 11 Pass-through of the VAT rate cut to prices for products taxed at the regular rate. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 31,896, and the number of clusters is 27

shocks on retail prices. Several studies find that intra-firm prices are more flexible to cost shocks and characterized by higher pass-through rates, compared to arm's length prices (Gopinath & Itskhoki, 2010; Hellerstein & Villas-Boas, 2010; Hong & Li, 2017).²⁹ This result is consistent with theoretical models where markups on marginal costs act as a buffer absorbing cost shocks and menu cost models. Since our data include both private label products and independent brands (cf. Appendix A), we are able to investigate whether these findings carry over to the incidence of the temporary VAT change. As we will show in the following, the patterns are very similar.

In the case of private labels, producers are mere suppliers of goods, sometimes even owned by the retailers, while the retail chains are responsible for brand design, pricing, and marketing. This also means that the supermarket chain can adjust the sales price of the product as it wishes. When it comes to independent brand products, things are different. Here, it may be more appropriate to consider supermarkets as intermediaries on a two-sided market, enabling an exchange between the producers of a good, the owner of the brand (who may or may not be the same), and the

²⁹ Based on data from Spanish gas stations, Bajo-Buenestado and Borrella-Mas (2022) find that the pass-through of a tax on prices is significantly higher for vertically integrated gas stations.

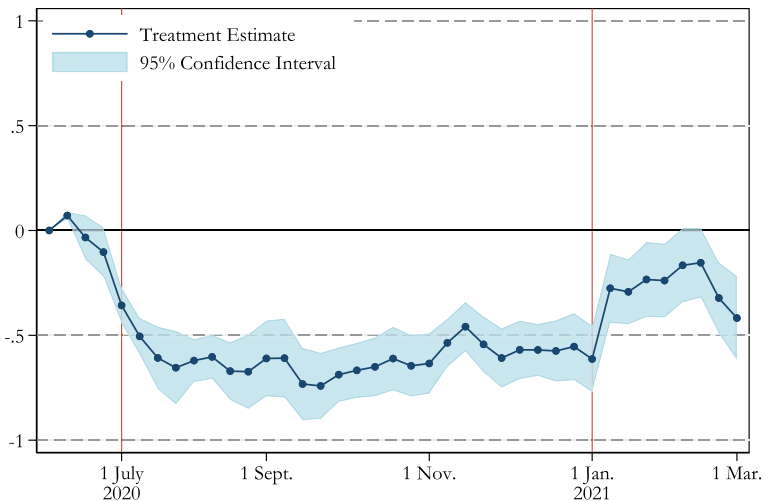


Fig. 12 Pass-through of the VAT rate cut to prices for products taxed at the reduced rate. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 31,945, and the number of clusters is 20

consumers.³⁰ Producers and supermarket chains negotiate over the pricing strategy and the presentation of a product. This has two implications. First, both suppliers and supermarkets exert some market power and will charge a markup on marginal costs, giving rise to higher prices due to 'double marginalization' (Hong & Li, 2017). Second, the need to renegotiate with the supplier limits the flexibility supermarkets have with regard to sales price adjustments. In Germany and Austria (and most other European countries), the price tags on products and supermarket shelves show after-tax prices, i.e., prices that include the VAT. Thus, after-tax prices serve as a yardstick for consumers when comparing product prices. Due to that, producers and supermarket chains often agree on a final sales price that includes the VAT when negotiating over the pricing strategy. Although a re-negotiation may be possible in case of extraordinary events, such as a temporary VAT reduction, it appears

³⁰ There is disagreement in the literature about whether retail stores should be viewed as two-sided markets. In Armstrong (2006)'s opinion, the answer is yes. His opinion is based on the notion that retail stores share features of platforms as they allow an exchange between producers and their customers. Rysman (2009), however, views retail stores as one-sided markets, arguing that "the retailer takes possession of the product and sells the product as it wishes, and the wholesaler has no concern for how many units the retailer is able to sell" (p. 126). In our view, Armstrong's characterization provides an accurate description of the relationship between independent suppliers featuring their own brands, supermarkets, and customers, whereas Rysman's characterization best describes the situation in which supermarkets are responsible for the pricing and branding of a product.

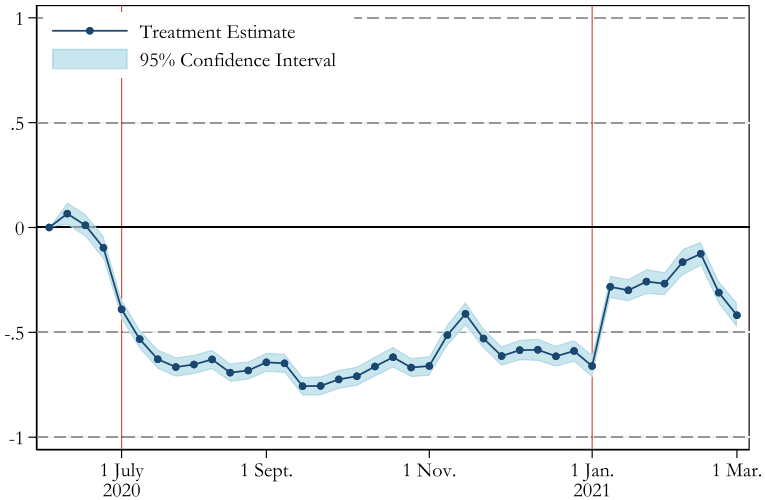


Fig. 13 The pass-through for food and non-alcoholic beverages. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). White-robust standard errors are computed. The number of products is 36,514

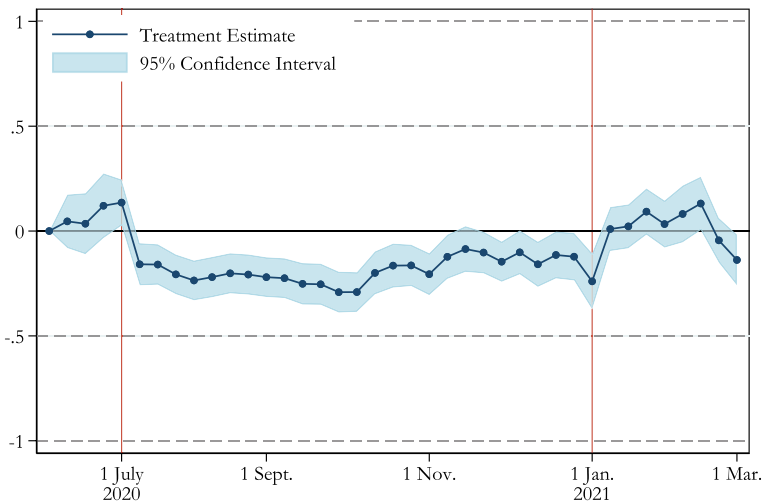


Fig. 14 The pass-through for alcoholic beverages. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). White-robust standard errors are computed. The number of products is 6989

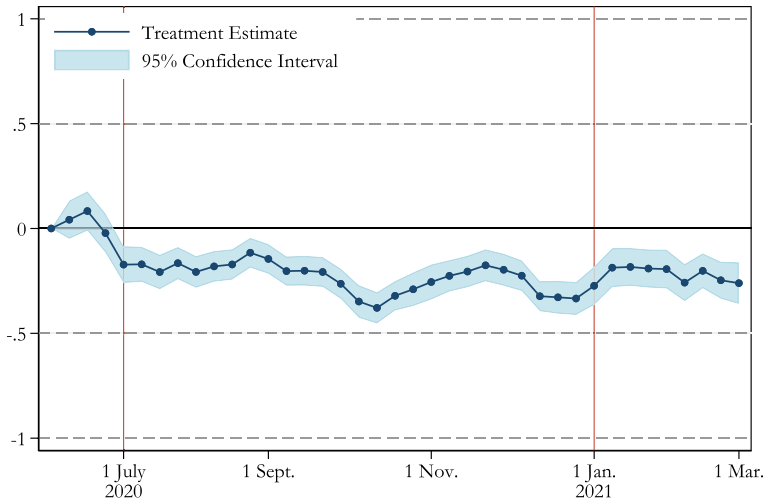


Fig. 15 The pass-through for hygiene and cosmetic products. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). White-robust standard errors are computed. The number of products is 6187

likely that the sales prices of the products of independent suppliers exhibit some stickiness, which would limit the pass-through of a VAT rate change to consumer prices.

Based on these arguments, one would expect that the pass-through of the temporary VAT rate cut is smaller for brand products of independent suppliers and larger for private labels.³¹ To test this conjecture, we re-estimate Eq. (1) separately for the two product groups. The results are shown in Figs. 16 and 17. In line with our conjecture, we find that the estimated pass-through rate of the VAT reduction is considerably larger for private labels (Fig. 16) compared to independent brand products (Fig. 17). For private labels, the pass-through rate is even larger than 100%, implying an overshifting of the temporary VAT reduction to consumers. When it comes to brand products, the estimated pass-through rate is roughly 50%, meaning that only half of the VAT rate cut was passed on to consumers.

To gain further insights, Figs. 18 and 19 show the share of REWE private label and brand products, respectively, whose prices are lower (green-shaded area), higher (red-shaded area), or the same (gray-shaded area) in a certain week than they were in the first week of May 2020. As expected, prices of private label products were changed much more frequently than prices of independent brand products. As

³¹ A theoretical model which generates this prediction for non-tax cost shocks is developed by Hong and Li (2017).

mentioned above, this is consistent with the view that the cost of price changes for firms is higher for independent brand products.

7.2 Results for different product groups

Our results so far suggest that the pass-through of the temporary VAT reduction is notably higher for private label products than it is for brand products. However, this result should be interpreted with caution because these two categories comprise different product types. For example, the share of private label products is higher among food and beverages (9.7%) than among hygiene and cosmetic products (4.4%) as well as alcohol and tobacco (0.1%). This raises the question of whether the different pass-through rates we observe for private label and brand products are driven by the composition of the two product categories. To answer this question, we estimate the following difference-in-difference specification separately for four different product groups, namely (i) food & beverages taxed at the regular VAT rate, (ii) food & beverages taxed at the reduced VAT rate, (iii) alcohol & tobacco, and (iv) hygiene and cosmetic products:

$$p_{i,w} = \alpha \times \Delta \text{VAT}_{i,w} + \beta \times \Delta \text{VAT}_{i,w} \times D_i^{PL} + \mu_i + \theta_w \times \text{COICOP}_{4\text{-digit}} + \varepsilon_{i,w} \quad (2)$$

As before, the dependent variable $p_{i,w}$ is the average price index of product i in week w . The variable $\Delta \text{VAT}_{i,w}$ measures the relative change in the VAT burden for product i in week w . Between June 1 and December 31, 2020, this variable takes on the value -2.52% for products taxed at the regular VAT rate and -1.87% for products taxed at the reduced VAT rate (cf. Sect. 5.1). Before June 1 and after December 31, 2020, $\Delta \text{VAT}_{i,w}$ is equal to zero. D_i^{PL} is a dummy variable indicating whether product i is a private label product ($D_i^{PL} = 1$) or a brand product ($D_i^{PL} = 0$). Consequently, α is an estimate of the VAT pass-through rate for brand products, while β measures the difference between the pass-through rate for private label vs. brand products. The rest of Eq. (2) is identical to Eq. (1): θ_w is a week-fixed effect, which we interact with dummy variables indicating a product's COICOP class, μ_i is a product-fixed effect, and $\varepsilon_{i,w}$ is the residual error term.

The results from Eq. (2) are presented in Table 2. We find that for all product groups, the VAT pass-through is significantly higher for private label products than for brand products. Thus, the results in Sect. 7.1 are not driven by the assortment of private label and brand products. We also find that the overshifting of the VAT rate cut for private label products pertains to all product groups but hygiene & cosmetic products. In contrast, for brand products, the pass-through rate is always smaller than 100% (in absolute terms).

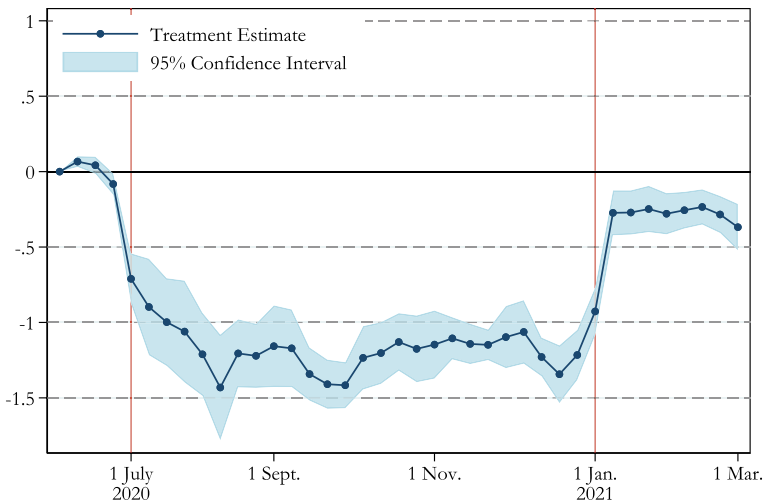


Fig. 16 Pass-through of the VAT rate cut to prices for private label products. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 12,741, and the number of clusters is 42

8 Conclusion

On June 3, the German federal government announced a large fiscal stimulus package to combat the economic consequences of the Corona pandemic. The most important measure of that package was a temporary reduction of VAT rates. We study the effect of the VAT rate cut and subsequent hike on German supermarket retail prices using an extensive webscraped dataset covering more than 68,000 product prices per day.

The results of our analysis indicate a strong price response to the temporary VAT rate cut. After the reduction of VAT rates, we observe a decline in prices of around 1.3%, suggesting that roughly 70% of the tax cut was passed on to consumers. Pass-through for food and generally goods taxed at the reduced VAT rate is higher than for alcoholic beverages, tobacco, and cosmetics. One explanation would be that demand for food is less elastic. In contrast to Crossley et al. (2014), we do not find that prices begin to rise again even before the VAT cut expires. Even after VAT rates returned to their original levels in January 2021, German supermarket prices increased by less than what a symmetric shifting of the VAT increase would imply.

Another important finding is that vertical market structure has played an important role for the consumer price effects of the VAT cut. Prices of private label products have reacted more often to the VAT rate change and more strongly. On average,

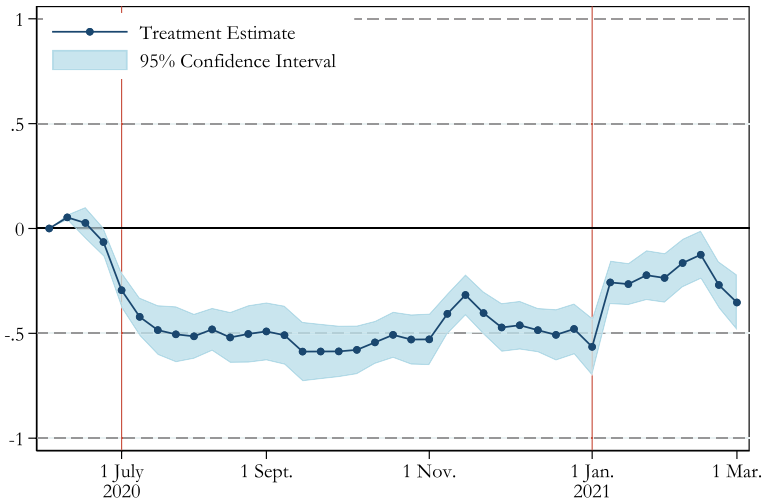


Fig. 17 Pass-through of the VAT rate cut to prices for brand products. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 59,604, and the number of clusters is 47

more than the full VAT cut was passed on to consumers for these products. Prices of independent brand products were cut by much less than the VAT change on average, and for many of these products, the prices were not changed at all. This is consistent with theories where cost markups act as buffers for cost shocks as well as menu cost theories, where changing or renegotiating prices is costly. This finding is also consistent with patterns reported in empirical studies on the pass-through of non-tax cost shocks caused by exchange rate fluctuations or commodity price changes. Since private label products are more important for consumers with lower incomes, this asymmetry may be considered as welcome from a policy perspective because low income households react more strongly to price reductions and they are generally more affected by the crisis.

Overall, a high rate of pass-through of the temporary VAT cut was probably intended, but it is not necessarily critical for achieving a stabilizing effect. If firms rather than consumers benefit from VAT cuts, then this may help them to survive a crisis and save jobs. The additional, sector specific VAT cuts for hotels and restaurants, which happened in Germany and Austria, are clearly meant to help the companies rather than the consumers. However, general VAT cuts are certainly not the most effective instrument to support firms in a crisis, in particular in a situation like the COVID-19 pandemic, which has affected different firms very differently. The tax advantage from a VAT cut is proportional to a firm's sales. Therefore, the largest benefits of a general VAT cut would go to the firms whose sales are least affected by the crisis. 'Crisis

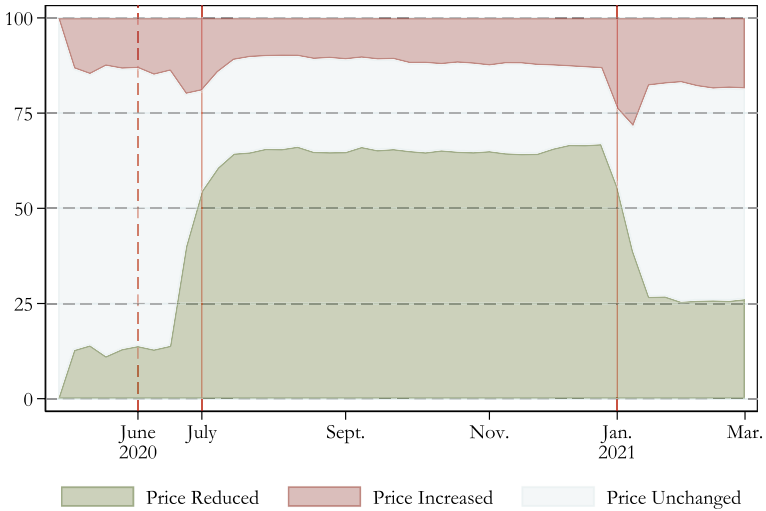


Fig. 18 Share of REWE products with price changes since May 2020 (in %)—private label products. *Notes* For each point in time indicated on the abscissa, the figure shows the share of store brand REWE products (in %) whose prices are lower (green shaded area), higher (red shaded area), or the same (white area) compared to the first week of May 2020. The dashed vertical line indicates the day of the announcement of the temporary VAT reduction (June 3, 2020), the first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021) (Color figure online)

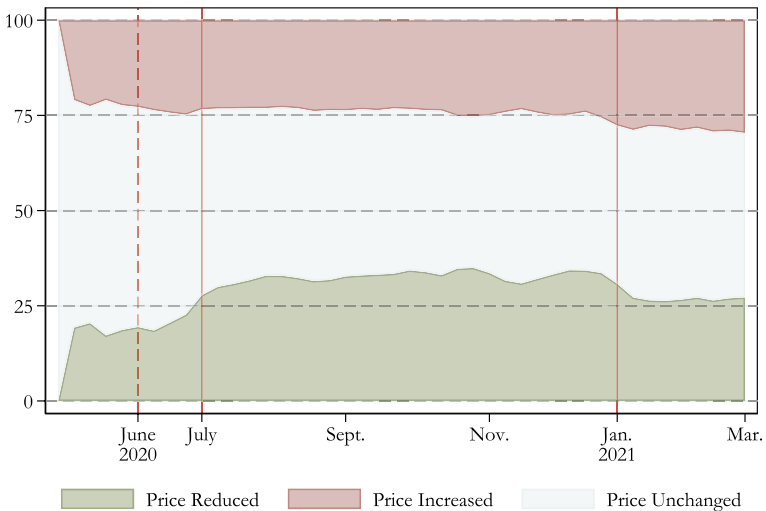


Fig. 19 Share of REWE products with price changes since May 2020 (in %)—brand products. *Notes* For each point in time indicated on the abscissa, the figure shows the share of REWE products from brands of independent suppliers (in %) whose prices are lower (green shaded area), higher (red shaded area), or the same (white area) compared to the first week of May 2020. The dashed vertical line indicates the day of the announcement of the temporary VAT reduction (June 3, 2020), the first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021) (Color figure online)

Table 2 VAT pass-through for different product groups—difference-in-difference estimation

	(1) Food & beverages taxed at regular VAT rate	(2) Food & beverages taxed at reduced VAT rate	(3) Alcohol & Tobacco	(4) Hygiene & cosmetics
Δ VAT	-0.730** [0.039]	-0.598** [0.012]	-0.287** [0.030]	-0.062** [0.022]
Δ VAT \times D^{PL}	-0.919** [0.042]	-0.674** [0.015]	-0.803** [0.248]	-0.880** [0.030]
Observations	134 438	890 498	199 903	156 838
No. of Products	4 577	31 972	6 996	6 179
No. of REWE Products	4 053	26 176	6 340	5 533
No. of Billa Prod- ucts	524	5 796	656	646

The table shows the coefficient estimates for α and β of Eq. (2). Line Δ VAT shows the estimated pass-through of the VAT reduction to prices for brand products, line Δ VAT \times D^{PL} the difference between the pass-through for private label vs. brand products. For example, a coefficient of -0.5 means that the pass-through is 50%, -1 means that the pass-through is 100%. White-robust standard errors are reported in parentheses

*/** significance at the 5%/1% level

winners' like digital companies or indeed supermarkets would get most of the help although they do not need it. This suggests that other, more targeted instruments would be more effective.

It is important to bear in mind two important limitations of our analysis. First, we use data from just one supermarket chain, even if it is a very large one. To what extent the results can be generalized is an open question. Second, the economic situation during the period we consider was highly unusual and volatile, and both economies were subject to various shocks. While we have provided evidence suggesting Austrian supermarket prices are an appropriate counterfactual, the shocks related to the economic crisis may still have affected the two economies differently. These caveats should be taken into account in the interpretation of the results.

Appendix A: Background information and description of data

The characteristics of supermarket retail are very similar in Germany and Austria. In both countries, the market is highly concentrated. In Germany, the largest retailers are EDEKA (market share in 2019: 24.5%), REWE (market share in 2019: 17.8%),

LIDL (market share in 2019: 16.5%), and ALDI (market share in 2019: 11.7%).³² They all operate nationwide. In Austria, Billa's (market share in 2019: 34.1%) biggest competitor is SPAR, with a market share in 2019 of 32.8%. The product assortments of the largest retailers in both countries comprise brands of independent suppliers as well as products marketed under brands owned by the retailers themselves (private labels). REWE's three major private labels, for example, are *Ja!* (*Yes!*), a discount label, *REWE Beste Wahl* (*REWE Best Choice*), which is part of the medium price segment, and *REWE Bio* (*REWE Organic*), which is REWE's label for organic products. Billa also has a discount label named *Clever*, a medium price private label named *Billa* (same name as the chain), and an organic label named *Billa Bio* (*Billa Organic*).

Since our analysis covers only one supermarket chain, it is important to get an idea about its customer base. As a starting point, Fig. 20 of Appendix B shows the geographical distribution of REWE and Billa stores in Germany and Austria, respectively. Stores of both chains can be found across the whole of both countries, although—unsurprisingly—the concentration of stores is higher in the proximity of large cities. Altogether, there are 3693 REWE stores in Germany and 1248 Billa stores in Austria (as of September 2021), which makes 4.4 REWE stores per 100,000 inhabitants in Germany and 14.1 Billa stores per 100,000 inhabitants in Austria.

Reflecting its huge geographical outreach, Fig. 21 shows that the majority of German households regularly buy at REWE. The figure compares the share of regular REWE customers to the share of regular customers of REWE's biggest competitors in Germany—EDEKA, LIDL, and ALDI. The numbers in Fig. 21 indicate what share of German households has regularly made purchases at the stores of the four supermarket chains in 2020, the year of the temporary VAT cut.³³ According to these numbers, three quarters of German households regularly bought goods at REWE. Due to that, it seems fair to say that price responses of the temporary VAT rate cut observable at REWE have a noticeable impact on German households.

Table 3 shows the number of products as well as average product prices included in our dataset separately for 'Classification of Individual Consumption According to Purpose' (COICOP) product classes and the two supermarket chains. In addition, the table also shows the weights the single COICOP classes have in the German CPI.

COICOP is published by the UN Department of Economic and Social Affairs. Products are grouped into divisions indicated by 2-digit codes, groups indicated by 3-digit codes, and classes indicated by 4-digit codes. COICOP is an integral part of the system of National Accounts and used, *inter alia*, for the establishment of weights for the computation of consumer price indexes and the calculation of purchasing power parities.

³² While REWE and EDEKA are 'conventional' supermarket chains, LIDL and ALDI are discounters. Together, these four chains represent about 70% of the supermarket retail market in Germany.

³³ The data are provided by *Gesellschaft für Konsumforschung* the largest market research institute in Germany, and based on a representative sample of roughly 30,000 German households.

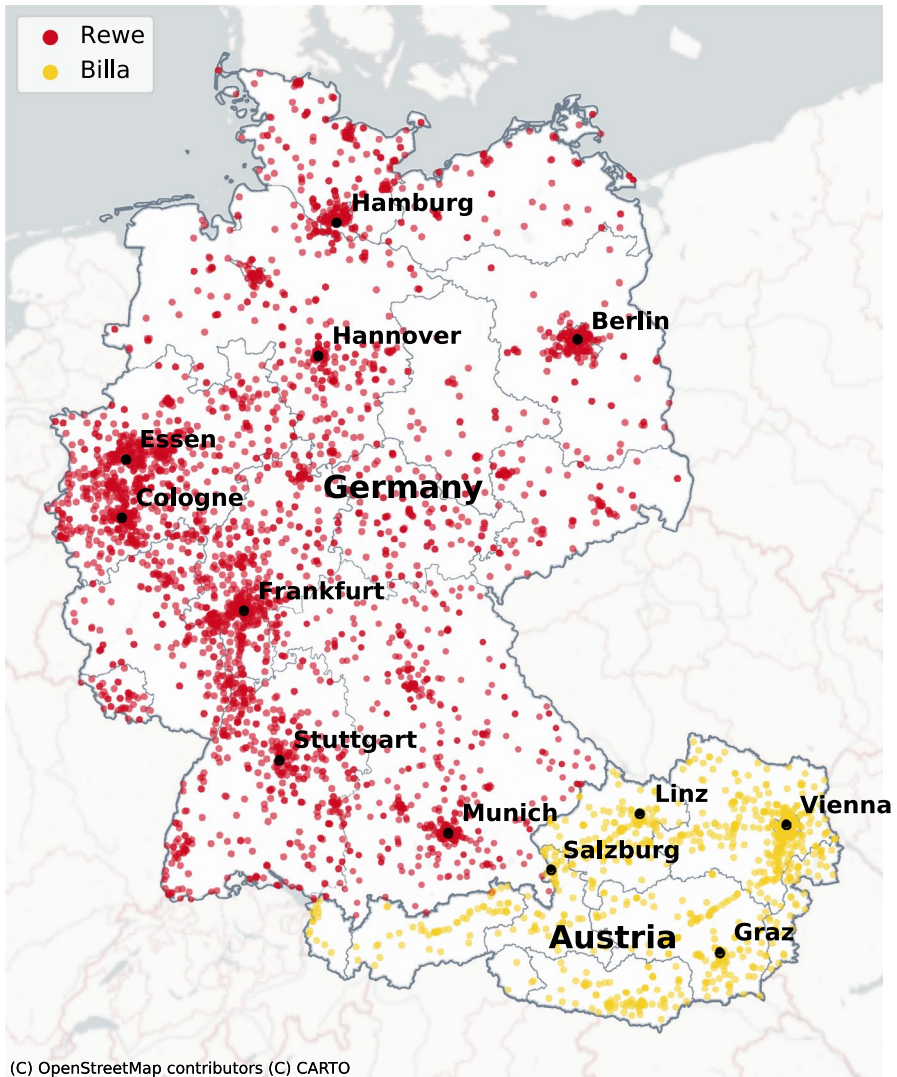


Fig. 20 Geographical distribution of REWE and Billa stores. *Notes* The figure shows the geographic distribution of all 3693 physical Rewe stores in Germany and 1248 physical Billa stores in Austria. *Source* REWE Marktfinder and Billa Marktfinder

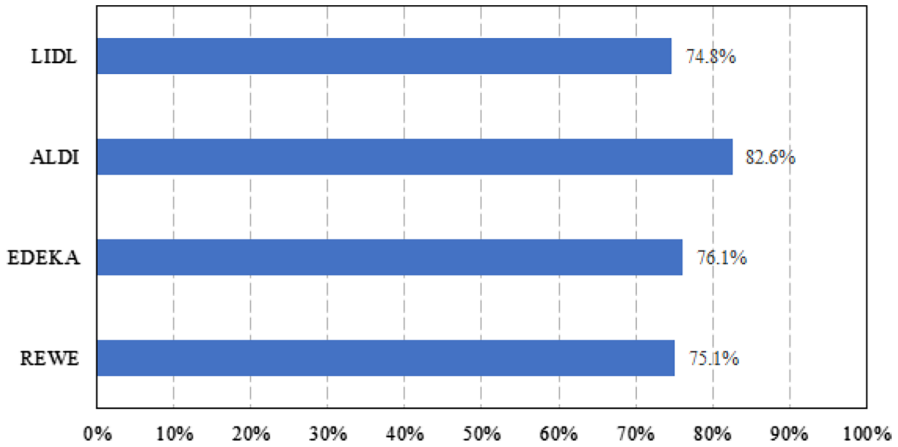


Fig. 21 Share of German household regularly buying at REWE & Co. *Notes* The figure shows the share of German households indicating that they regularly buy at REWE, EDEKA, ALDI, and LIDL. Data source: *Gesellschaft für Konsumforschung*

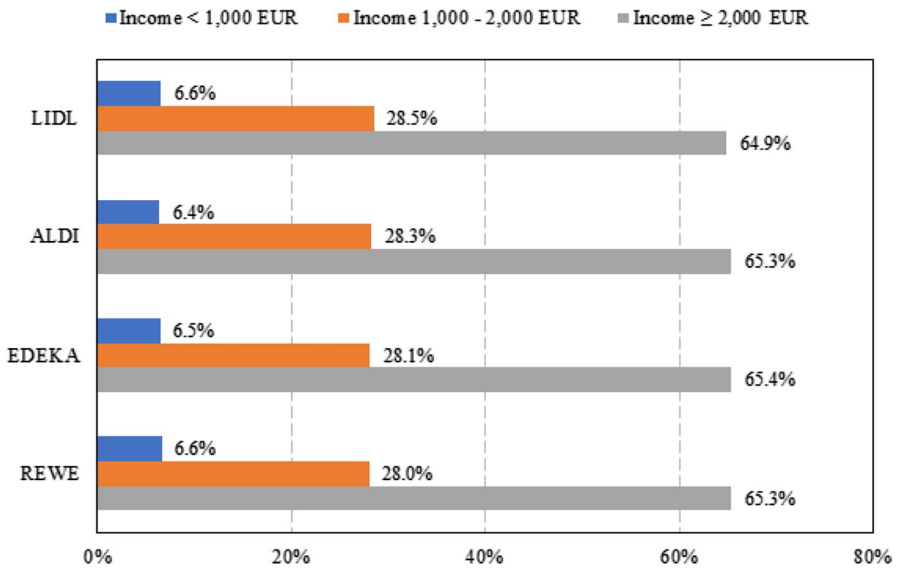


Fig. 22 Share of German household regularly buying at REWE & Co.—by Income Group. *Notes* The figure shows the share of German households indicating that they regularly buy at REWE, EDEKA, ALDI, and LIDL depending on household income. Data source: *Gesellschaft für Konsumforschung*

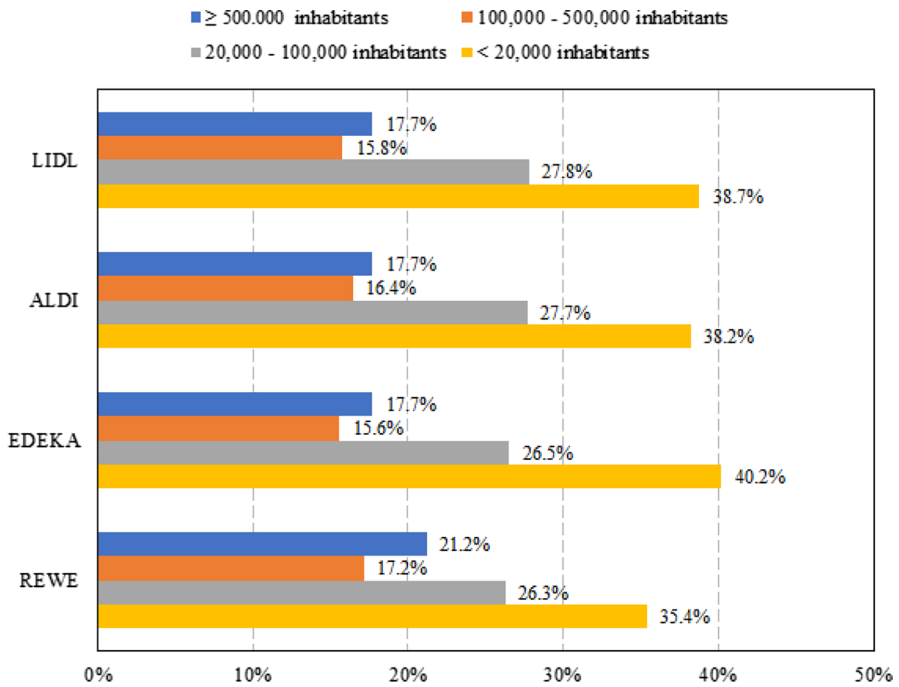


Fig. 23 Share of German household regularly buying at REWE & Co.—by town size. *Notes* The figure shows the share of German households indicating that they regularly buy at REWE, EDEKA, ALDI, and LIDL, depending on the population size of the town where the household lives. Data source: *Gesellschaft für Konsumforschung*

Figures 22 and 23 show the composition of regular REWE, EDEKA, LIDL, and ALDI customers in terms of household income (differentiating between three income brackets: less than 1000 EUR, 1000–2000 EUR, and more than 2000 EUR) as well as the population number of the town where the customers live (four brackets: less than 20,000 inhabitants, 20,000–100,000 inhabitants, 100,000–500,000 inhabitants, more than 500,000 inhabitants). The figures show that with regard to household income, the composition of the customers of the four supermarket chains is very similar. When it comes to town size, though, REWE has a larger share of customers living in large cities and a smaller share of customers residing in small towns.

Table 3 Summary statistics of product price data from Germany and Austria by COICOP category

COICOP code	CPI weight (%)	COICOP class	REWE (GER)		Billa (AUT)	
			Products (#)	Ø-Price (in €)	Products (#)	Ø-Price (in €)
19.07		All	55,337	11.23	8504	3.86
01	9.69	Food and non-alcoholic beverages	30,194	3.94	6320	3.18
01.1	8.49	Food	23,728	3.38	5395	3.22
01.1.1	1.50	Bread and cereals	5305	3.68	1423	2.37
01.1.2	1.86	Meat	3187	4.09	477	9.89
01.1.3	3.17	Fish and seafood	852	5.87	179	4.98
01.1.4	1.42	Milk, cheese, and eggs	2923	1.91	875	2.09
01.1.5	0.23	Oils and fats	486	6.29	116	4.31
01.1.6	0.89	Fruits	1040	3.04	205	3.21
01.1.7	1.11	Vegetables	1821	2.49	594	2.19
01.1.8	0.71	Sugar, jam, honey, and chocolate	3279	3.38	746	3.03
01.1.9	0.45	Food products n.e.c	4835	3.14	780	2.37
01.2	1.20	Non-alcoholic beverages	6466	5.99	925	2.95
01.2.1	0.40	Coffee, tea and cocoa	2421	8.36	401	4.53
01.2.2	0.79	Mineral waters, soft drinks, juices	4045	4.58	524	1.75
02	1.70	Alcoholic beverages, tobacco, narcotics	6333	14.34	656	9.36
02.1	1.70	Alcoholic beverages	6333	14.34	656	9.36
02.1.1	0.35	Spirits	2111	26.74	192	16.33
02.1.2	0.75	Wine	2114	8.70	340	8.21
02.1.3	0.60	Beer	2108	7.58	124	1.75
03	3.27	Clothing and footwear	1469	43.47	17	1.12
03.1	3.27	Clothing	1469	43.47	17	1.12

Table 3 (continued)

COICOP code	CPI weight (%)	COICOP class	REWE (GER)		Billa (AUT)	
			Products (#)	Ø-Price (in €)	Products (#)	Ø-Price (in €)
03.1.2	3.27	Garments	1469	43.47	17	1.12
05	1.65	Furnishing, household equipment and routine maintenance	8736	26.29	515	4.72
05.2	0.40	Household textiles	709	14.76	7	0.86
05.4	0.37	Glassware, tableware and household utensils	5654	32.71	22	10.36
05.5	0.45	Tools and equipment for house and garden	101	8.66	33	7.25
05.5.2	0.45	Miscellaneous accessories	101	8.66	33	7.25
05.6	0.43	Goods and services for routine household maintenance	2272	14.69	453	4.32
05.6.1	0.43	Non-durable household goods	2272	14.69	453	4.32
06	1.09	Health	319	14.85	9	4.59
06.1	1.09	Medical products, appliances, and equipment	319	14.85	9	4.59
06.1.1	0.97	Pharmaceutical products	184	8.34	–	–
06.1.2	0.12	Other medical products	135	23.73	9	4.59
09	0.43	Recreation and culture	2754	17.43	347	2.63
09.3	0.43	Other recreational items and equ., gardens and pets	2754	17.43	341	2.61
09.3.4	0.43	Pets and related products	2754	17.43	339	2.62
12	1.24	Misc. goods and services	5532	11.80	646	5.00
12.1	1.24	Personal care	5532	11.80	646	5.00
12.1.2	0.05	Electric appl. for pers. care	29	42.21	–	–
12.1.3	1.19	Other appliances, articles and products for personal care	5503	11.64	646	5.00

The table shows quantities and prices of REWE and Billa products from the first week of June 2020, i.e. our base week. The CPI weights can be found online at: <https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Verbraucherpreisindex/FAQ/anteil-gueter-warenkorb.html>

Appendix B: Additional tables and figures

See Tables 4, 5, 6 and Figs. 24, 25, 26, 27, 28, 29, 30, 31.

Table 4 History of main COVID-related events and containment measures in Germany

Jan. 2020	01/27: First confirmed COVID-19 case in Bavaria
Mar. 2020	03/01: Facilitated access to short-term working scheme ('Kurzarbeit')
	03/10: Events with more than 1,000 participants banned (recommendation)
	03/16: First lockdown: Closure of borders with France, Switzerland, Austria, Denmark and Luxembourg; transportation of goods exempted; closure of all non-essential retail (supermarkets, pharmacies, banks, and pet shops exempted); restaurants restricted to 30 guests
	03/19: Liquidity provisions for firms and self-employed individuals via loans, grants and credit guarantees; deferral of tax payments
	03/20: Curfew in Bavaria: Prohibition to leave the own dwelling other than to go to work and to supermarkets, pharmacies and to medical appointments, among other things; restriction of restaurants to take-away food; curfew extended to the rest of Germany on March 22
	03/22: Meetings of more than two people forbidden; maintenance of 1.5 m social distancing mandatory in public
Apr. 2020	04/20: Re-opening of retail (up to 800 m ²) subject to hygiene restrictions
	04/27: Mandatory mask wearing in supermarkets and public transport
May 2020	05/04: Re-opening of schools and hair dressing salons
	05/06: Re-opening of other retail
	05/15: Easing of border controls with neighboring countries (free travel starting from mid-June)
June 2020	06/29: Stimulus package, including cash payments for households with children
July 2020	07/01: Reduction of VAT until January 1, 2021
	07/08: Provision of non-repayable funds for companies with annual revenues up to 750 million euro
Nov. 2020	11/02: 'Lockdown light'/'Wave breaker lockdown': Restaurants restricted to take-out services again; maximum of ten people from two households can gather
Dec. 2020	12/01: Tightening of social contacts: at most five people from two households can meet; for retail with more than 800 m ² only one customer per 20 m ² (instead of 10 m ² per customer as before)
	12/16: Second lockdown: Closure of non-essential retail and schools
Mar. 2021	03/01: Re-opening of some retail, e.g. book stores and hair dressing salons; gatherings of up to five people possible since March 8

Source: Official communiques of the [German Government](#)

Table 5 History of Main COVID-related Events and Containment Measures in Austria

Febr. 2020	02/25: First confirmed COVID-19 cases in Tyrol
Mar. 2020	03/01: Facilitated access to short-term working scheme ('Kurzarbeit')
	03/15: Ban on public gatherings of more than five people
	03/16: First 'Hard Lockdown': Closure of all non-essential retail (supermarkets, pharmacies, banks, and pet shops exempted); nationwide curfew: prohibition to leave the own dwelling other than to go to work and to supermarkets, pharmacies and to medical appointments, among other things; grants for self-employed individuals and small companies
	03/17: Closure of restaurants
	03/30: Mandatory mask wearing in supermarkets
Apr. 2020	04/08: Liquidity provisions for firms via credit guarantees; deferral of tax payments
	04/14: Lifting of restrictions: re-opening of retail up to 400 m ²
May 2020	05/01: Re-opening of all retail and hair dressing salons subject to hygiene restrictions and a maximum of one customer per 10 m ²
	05/15: Re-opening of restaurants
	05/30: Removal of restriction that shops can only serve one customer per 10 m ² at the same time
June 2020	06/29: Stimulus package, comprising cash payments for households with children, reduction of income tax, investment subsidies and reduction of VAT for hospitality services and cultural locations
	06/15: Mandatory mask wearing only in public transport and for contact-intensive services but not in supermarkets and restaurants anymore
July 2020	07/24: Face masks mandatory again in supermarkets
Oct. 2020	10/23: Public gatherings restricted to six people indoors and twelve people outdoors except business meetings
Nov. 2020	11/02: 'Lockdown Light': Nation-wide curfews for non-essential trips between 8pm and 6am; restaurants restricted to take-away services; retail remained open under existing hygiene rules
	11/17: Second 'Hard Lockdown' until December 7: Nation-wide curfews extended to whole day; closure of all non-essential retail, except supermarkets, pharmacies, banks, and pet shops (subject to hygiene restrictions and at most one customer per 10 m ²)
Dec. 2020	12/26: Third 'Hard Lockdown' until February 7, 2021
Febr. 2021	02/08: Re-opening of retail (up to one customer per 20 m ²), schools and cultural venues, e.g. museums. Contact-intensive services, e.g. hair dressing salons, require negative COVID-test

Source: Official communiques of the [Austrian Government](#)

Table 6 Results of event study analysis: coefficient estimates for the event study indicators

	(1) Estimated price effects	(2) Estimated pass-through rates
b_{-4}	0 [-]	0 [-]
b_{-3}	0.117** [0.013]	0.054** [0.007]
b_{-2}	0.036 [0.080]	0.028 [0.038]
b_{-1}	-0.146 [0.077]	-0.065 [0.035]
b_0	-0.682** [0.083]	-0.328** [0.042]
b_1	-0.965** [0.089]	-0.466** [0.046]
b_2	-1.130** [0.119]	-0.542** [0.059]
b_3	-1.183** [0.132]	-0.563** [0.067]
b_4	-1.186** [0.106]	-0.572** [0.055]
b_5	-1.127** [0.101]	-0.541** [0.054]
b_6	-1.219** [0.118]	-0.581** [0.063]
b_7	-1.197** [0.136]	-0.568** [0.070]
b_8	-1.142** [0.144]	-0.548** [0.071]
b_9	-1.172** [0.150]	-0.566** [0.072]
b_{10}	-1.366** [0.142]	-0.655** [0.072]
b_{11}	-1.382** [0.133]	-0.663** [0.069]
b_{12}	-1.355** [0.128]	-0.658** [0.064]
b_{13}	-1.305** [0.121]	-0.633** [0.059]
b_{14}	-1.243** [0.109]	-0.599** [0.051]
b_{15}	-1.162** [0.115]	-0.560** [0.054]
b_{16}	-1.216** [0.119]	-0.584** [0.058]
b_{17}	-1.205** [0.121]	-0.580** [0.059]

Table 6 (continued)

	(1) Estimated price effects	(2) Estimated pass-through rates
b_{18}	-0.974** [0.091]	-0.464** [0.048]
b_{19}	-0.821** [0.101]	-0.390** [0.055]
b_{20}	-0.978** [0.100]	-0.465** [0.051]
b_{21}	-1.100** [0.108]	-0.523** [0.055]
b_{22}	-1.061** [0.110]	-0.509** [0.054]
b_{23}	-1.131** [0.111]	-0.550** [0.052]
b_{24}	-1.179** [0.138]	-0.578** [0.064]
b_{25}	-1.107** [0.132]	-0.539** [0.061]
b_{26}	-1.217** [0.142]	-0.592** [0.067]
b_{27}	-0.526** [0.114]	-0.253** [0.051]
b_{28}	-0.543** [0.107]	-0.260** [0.049]
b_{29}	-0.458** [0.127]	-0.222** [0.058]
b_{30}	-0.483** [0.127]	-0.236** [0.058]
b_{31}	-0.348** [0.123]	-0.171** [0.055]
b_{32}	-0.276* [0.117]	-0.131* [0.055]
b_{33}	-0.574** [0.114]	-0.272** [0.053]
b_{34}	-0.749** [0.137]	-0.356** [0.063]
N	2,201,580	2,201,580

The table shows the coefficient estimates for the event study indicators. Column (1) shows the estimated price effects (measured in percent), and column (2) shows the estimated pass-through rates. Standard errors are clustered at the product class level (COICOP 4-digit level) and shown in brackets. $t = 0$ indicates the week of the VAT rate cut (first week of July 2020), $t = 27$ the week of the VAT rate hike (first week of January 2021). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The number of products is 63,841, and the number of clusters is 47.

***/** significance at the 5%/1% level

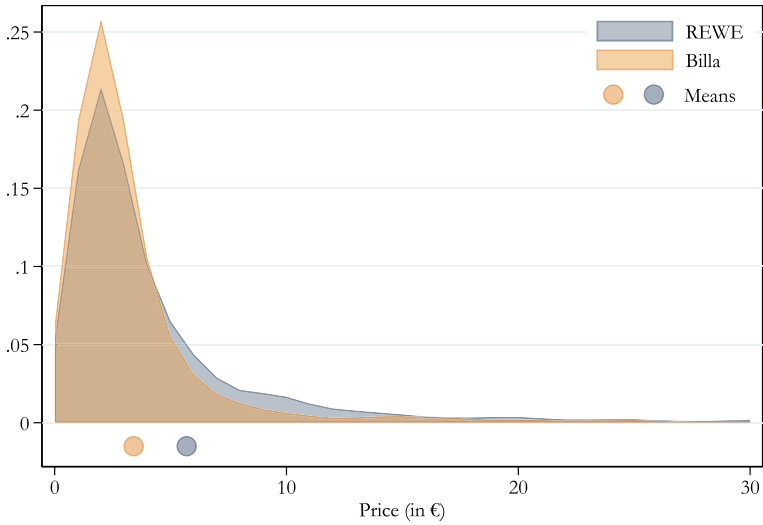


Fig. 24 Comparison of prices levels—reduced set of products. *Notes* The density plot is based on price data collected from the REWE and Billa online shops in the first week of June which serves as the base period in our analysis

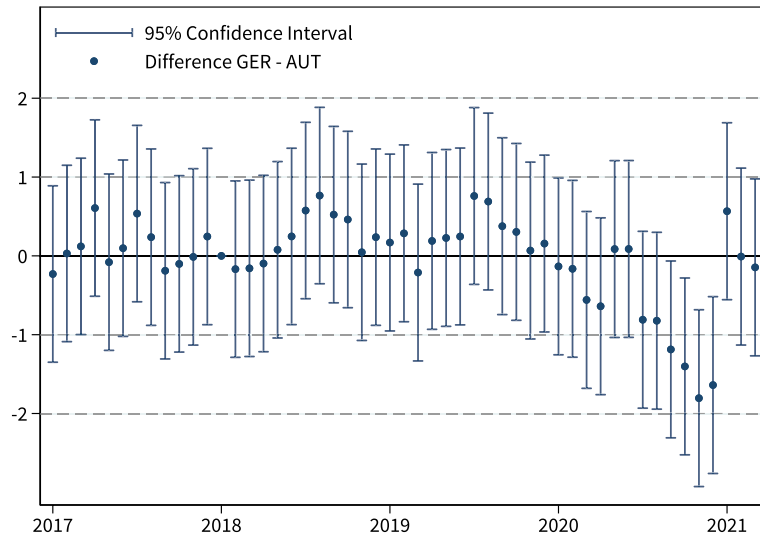


Fig. 25 Differences between prices in Germany and Austria since 2017. *Notes* The figure shows the absolute difference between the average monthly price indexes for 168 product groups across Germany and Austria (cf. Fig. 8). The whiskers indicate 95% confidence intervals. Data source: Eurostat

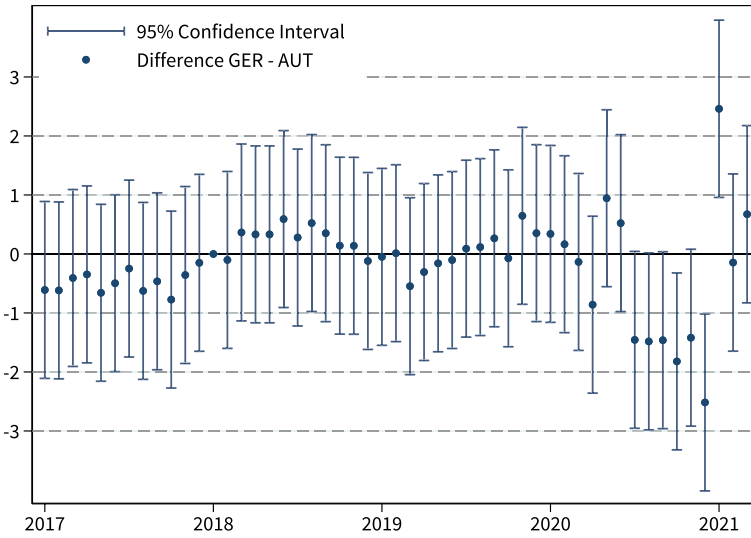


Fig. 26 Differences between prices for selected product groups in Germany and Austria since 2017. *Notes* The figure shows the absolute difference between the average monthly price indexes for food and non-alcoholic beverages, alcoholic beverages and tobacco, and hygiene and cosmetic products across Germany and Austria (cf. Fig. 7). The whiskers indicate 95% confidence intervals. Data source: Eurostat

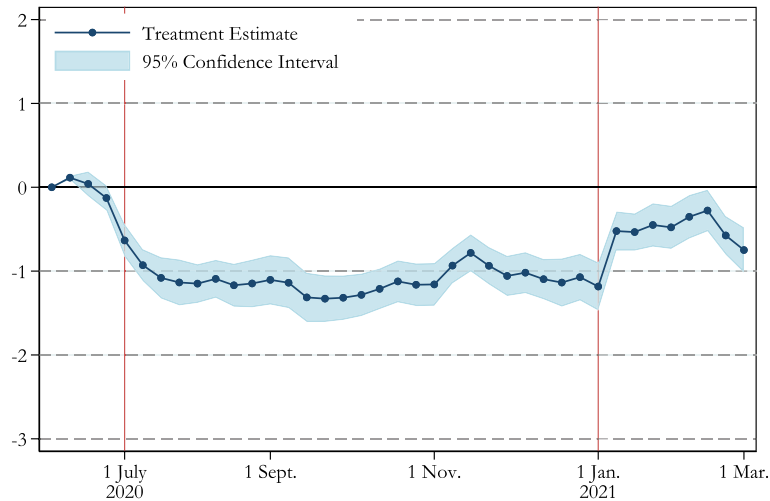


Fig. 27 Results of event study analysis (unweighted regression): impact of the VAT Rate Cut on Prices. *Notes* The figure shows the coefficient estimates for the event dummies along with the 95% confidence intervals. The y-axis indicates the price change in percent. The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 63,841, and the number of clusters is 47

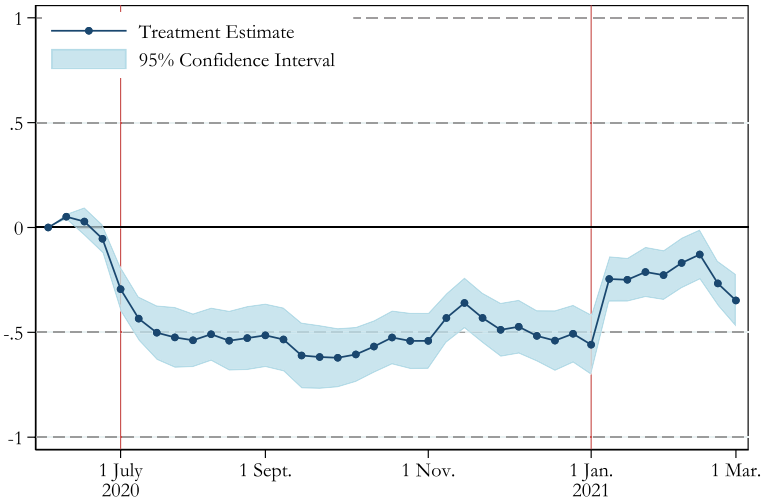


Fig. 28 Results of event study analysis (unweighted regression): pass-through of the VAT rate cut to prices. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product’s after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (−0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 63,841, and the number of clusters is 47

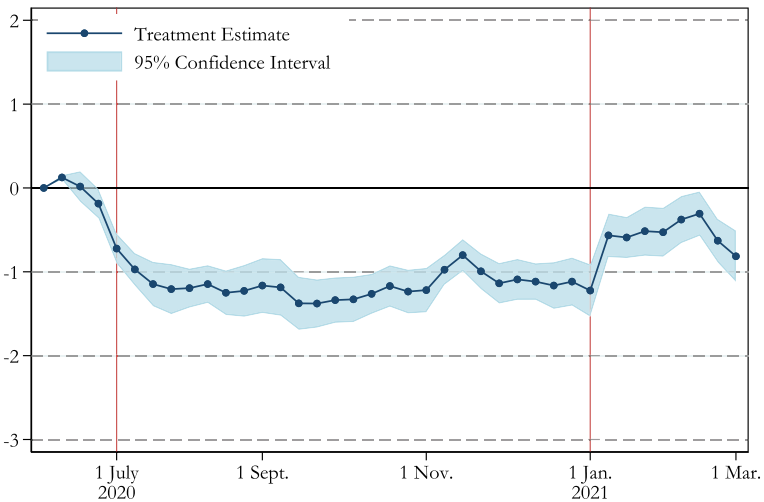


Fig. 29 Results of event study analysis (event dummies): reduced product set. *Notes* The figure shows the coefficient estimates for the event dummies along with the 95% confidence intervals. The y-axis indicates the price change in percent. The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the reversal of the VAT rate cut (January 1, 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 45,388, and the number of clusters is 26

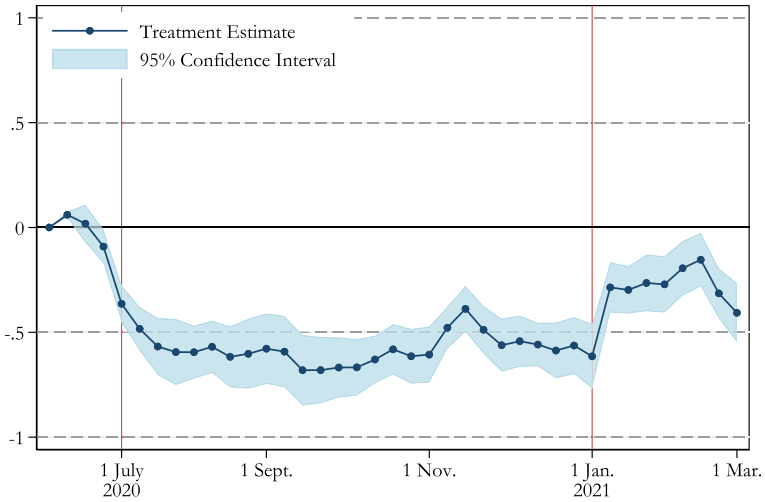
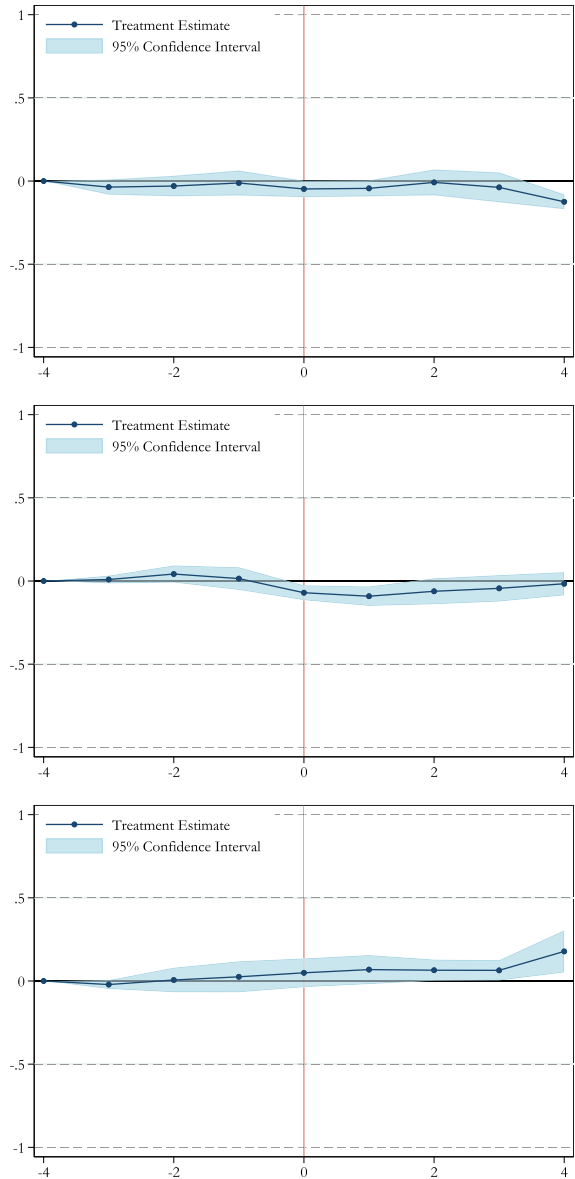


Fig. 30 Results of event study analysis (pass-through rate): reduced product set. *Notes* The figure shows the coefficient estimates when the event study indicators measure the change in the VAT burden relative to a product's after-tax price along with the 95% confidence intervals. The y-axis indicates the pass-through to prices (-0.5 means that the pass-through is 50%, and 1 means that the pass-through is 100%). The first week of June serves as a reference and the corresponding coefficient estimate is zero. Results are based on Eq. (1). The first solid vertical line indicates the day of the VAT rate cut (July 1, 2020), and the second solid vertical line indicates the day of the expiration of the VAT rate cut (January 1, 2021). The number of products is 45,388, and the number of clusters is 25

Fig. 31 Results of event study analysis (pass-through rate): placebo tests. *Notes* The figure shows the results of placebo tests. For the test, the treatment date was moved 6 (upper panel), 10 (middle panel) and 14 (lower panel) weeks back. Dark blue dots indicate coefficient estimates, and light blue areas indicate 95% confidence intervals. Results are based on Eq. (1). The solid vertical line indicates the day of the placebo treatment. Standard errors are clustered at the product class level (COICOP 4-digit level). The number of clusters is 47



Author contributions All authors contributed equally to the paper.

Declarations

Conflict of interest The authors declare no competing interests.

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