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The Pass-Through of Temporary VAT Rate Cuts: Evidence from German Supermarket Retail

Abstract

On 3 June 2020, the German government announced a temporary value added tax (VAT) rate reduction. VAT rates were reduced on 1 July 2020 and went back to their previous level on 1 January 2021. We study the price effects of the temporary VAT rate reduction using a web-scraped data set covering the daily prices of roughly 130,000 supermarket products. To identify the causal price effects, we compare the development of prices in Germany to those in Austria. Our findings indicate an asymmetric price response to the VAT rate cut and subsequent increase. The reduction of VAT rates led to a price decrease of roughly 1.3%, implying that about 70% of the tax cut were passed on to consumers. In contrast, the price effect of the VAT increase was only about half that size. We also study the link between tax incidence and the intensity of competition. Pass-through of the VAT reduction was higher in product groups with a large number of competing products. We rationalize this finding by analyzing consumption tax incidence in the 'love of variety' model of consumption.

JEL-Codes: E310, H220, H250.

Keywords: value added tax, tax incidence, fiscal policy, price effects, competition.

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1. Introduction

On 3 June 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 food and beverages', was reduced from 7% to 5%. The VAT rates returned to their previous level on 1 January 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.

While the pass-through of permanent VAT changes has been studied extensively (see e.g. Benedek et al., 2019; 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 VAT changes, most importantly because 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, allowing us to identify the causal price effects of the German temporary VAT rate cut. 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.[1] We collected daily prices for 120,000 products from REWE, a German supermarket chain, and for 9,000 products from Billa in Austria using a webscraping algorithm.

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 only started to increase again when the VAT reduction was repealed. However, the price increase in response to the VAT rate hike was only half the size of the price decline following the VAT rate cut. Thus, the adjustment of supermarket prices to VAT rate changes has been strongly asymmetric.

We also investigate the relationship between the degree of competition between suppliers and the speed and magnitude of the pass-through. So far, only few studies have investigated this relationship empirically.[2] We proxy the degree of competition by the

1 Austria reduced the VAT only in the hotel industry.

2 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. Inasmuch as low profit margins indicate a high level of competition, this finding may be interpreted as evidence that the VAT pass-through is higher

number of brands offering similar products in a product group. Our results indicate that the pass-through of the VAT rate cut is notably larger in product segments where more brands compete, thus providing evidence for a positive relationship between the VAT pass-through and competitive pressure. We rationalize this finding by introducing a consumption tax into the 'love of variety' model pioneered by Helpman and Krugman (1985). In general, our finding is compatible with the idea that taxes will be fully shifted to consumers in highly competitive markets where firms make zero profits. However, the price effects in response to the subsequent VAT rate hike are not compatible with this interpretation. Producers operating in highly competitive markets are also the ones who did not increase product prices to the pre-reform level after the VAT rate cut was repealed. They are responsible for the asymmetric price response to the temporary VAT reduction.

To the best of our knowledge, there are only two studies that provide empirical evidence on the pass-through of temporary VAT rate cuts to consumer prices. Crossley et al. (2014) analyze the price adjustments in response to a temporary 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 before a quick phasing out of the effect before the VAT rate was reversed again. Montag et al. (2020) also focus on the VAT reform in Germany and track the impact of the tax reduction 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 based on which the official consumer price index (CPI) for Germany is calculated, expenditures on fuel at gas stations account for only 2.5% of all purchases of German households. In contrast, the products we consider in our analysis account for more than 25% of German households' total expenditures. The price effects and consumption adjustments following 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 afterwards. Similarly, Benzarti et al. (2020) study the price effects of a VAT rate cut on hairdressing 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.

Also related to our study is a strand of the literature that studies 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 United States. Despite being typi-

in highly competitive markets. There is also evidence that the pass-through of excise taxes on alcohol (Hindriks and Serse, 2019), cigarettes (Harding et al., 2012), and fuel (Doyle Jr. and Samphantharak, 2008) is related to the intensity of spatial competition between retailers.

cally limited to several days only, 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).

Our results also feed into the discussion about the effectiveness of 'unconventional fiscal policies' (Feldstein, 2002) and the extent to which inflation expectations of households can be manipulated (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 demonstrate 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.

The rest of the paper is structured as follows: Section (2) describes the price data from Germany and Austria and provides some descriptive evidence on the pass-through of the temporary VAT reduction. In Section (3), we compare the situation in Germany and Austria during the course of the pandemic and explain why Austria constitutes an ideal counterfactual to study the price effects of the temporary VAT reduction in Germany. In Section (4), we estimate the pass-through of the temporary VAT rate cut and discuss our findings. In Section (5), we analyze the relationship between the degree of competition in a product market and the VAT pass-through. Section (6) concludes.

2. Data and Descriptive Statistics

In order 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 (market share: 17.8%) and the largest one in Austria (market share: 34.1%).[3] An automatized webscraping algorithm collects the relevant product information every day from both online shops, including the product ID, the product name, the (sub-) category it belongs to and the current retail product price. In general, online prices are the identical to those customers have to pay in 'physical' stores and do not vary across stores. In rare cases, though, different stores of the same chain charge different prices for the same product. Then, the online shops show the price interval for the product.[4] In these cases, we decided to consider the lower bound of that price interval in our analysis.

In the case of REWE, we collected up to 190,000 product prices per day, starting in September 2019. Data from Billa is available since 4 June 2020, that is, the first day after the announcement of the VAT reduction, and covers around 9,500 products per day.[5] Note

3 Source: The Nielsen Company.

4 As explained in Rickert et al. (2018), while the purchasing activities of supermarket chains are handled centrally by the headquarter, product pricing is done locally. Thus, in principle, it is up to the discretion of each store what prices to charge. However, we only found a negligible number of cases in which different stores charged different prices for the same product.

5 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.

that the assortment of products that is available to customers in the online shops exceeds the set of products that are available in physical stores. The assortment in physical stores is mostly restricted to food, beverages, and hygiene products. Online shops, in contrast, also feature a limited number of clothes, various electronic devices, as well as some kitchen and garden utensils. The prices that we collected already include the VAT.

Table 1: Coverage of Harmonized Product Sets and Share in Consumption Basket

		REWE		Billa	
	Basket Share (in %)	Abs. #	Rel. Share	Abs. #	Rel. Share
Hygiene, Cosmetics & Cloths	5.72	7978	6.55	705	7.76
Garden & Outdoor	0.62	2865	2.35	50	0.55
Non-alcoholic Beverages	0.79	6593	5.41	587	6.46
Home & Hobby Utensils	4.73	55 314	45.43	197	2.17
Coffee, Tea & Cocoa	0.40	2786	2.29	337	3.71
Kitchen Utensils	0.27	10 316	8.47	324	3.57
Food	5.68	22 999	18.90	4832	53.22
Fruits & Vegetables	2.00	957	0.79	241	2.65
'Sweet & Salty'	0.71	3761	3.09	807	8.89
Wine, Liquor & Tobacco	3.78	5305	4.36	661	7.28
Pet Supplies	0.43	2884	2.37	339	3.73
Total	25.13	121 758	100.00	9080	100.00

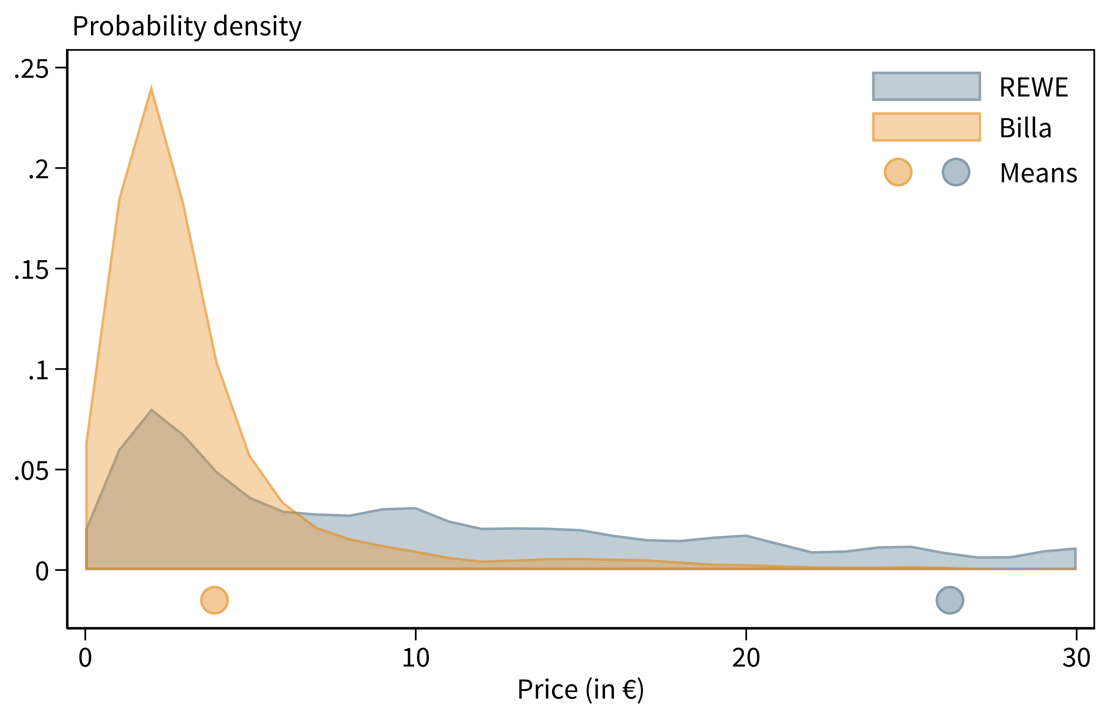
Notes: The product sets includes those products that were available in the online shops in first week of June 2020, which is our base week. The composition of the average consumption basket in Germany can be accessed online at: https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Verbraucherpreisindex/FAQ/anteil-gueter-warenkorb.html.

Table (1) provides an overview of the harmonized product set after excluding those product categories for which there is no counter-part in the product set of the other supermarket chain. To harmonize the product sets of REWE and Billa, we assign each product to one out of 186 'Classification of Individual Consumption According to Purpose' (COICOP) product classes.[6] Then, we drop all REWE products belonging to a COICOP product class not covered by the Billa assortment and vice versa. The harmonized data comprise around 120,000 products from REWE and 9,000 products from Billa. Among those, 'Food' and 'Home & Hobby Utensils' are the largest groups in both supermarket chains, followed by 'Hygiene, Cosmetics & Cloths'. The shares of the single product categories in relation to the total number of products offered in the online shops closely mirror their shares in the German CPI basket used to compute the official inflation rate (first column of Table (1)). All in all, about 25% of German households' total expenditures are spent on the products offered in the online shops.

6 The 'Classification of Individual Consumption According to Purpose' is the international reference classification of household expenditure. The European Union and its member states publish disaggregate price data for single COICOP product classes. Product classes are assigned 4-digit codes.

The distribution of prices is shown in Figure (1). Separate density estimates are provided for products from the REWE and Billa online shop, covering only the period before the VAT change and those products that are included in the harmonized product samples from Table (1) above. 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 26 euro at REWE.

Figure 1: Comparison of Prices Levels

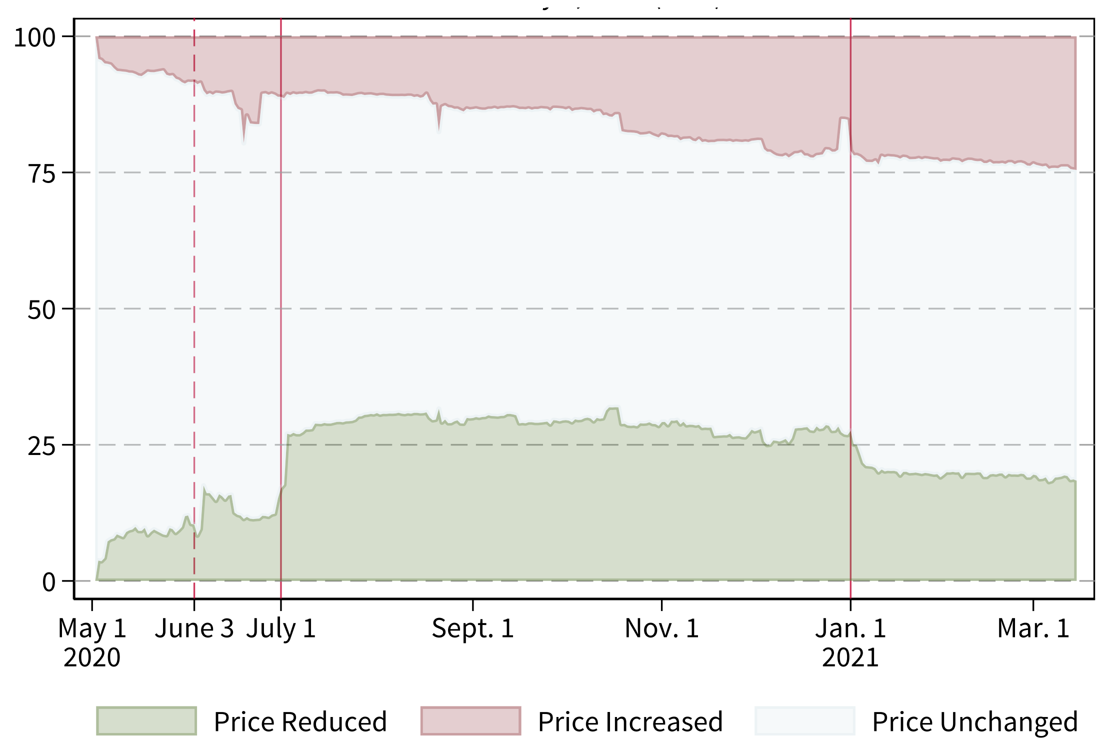


Notes: The density plot is based on price data collected from the REWE and Billa online shops between 4 June and 30 June 2020, i.e., the time period between the announcement and the implementation of the temporary VAT rate cut.

To get a first idea about the price dynamics around the announcement and implementation day of the VAT reduction, Figure (2) displays the share of REWE products whose prices were lower (green shaded area), higher (red), or the same (white) on a certain day than they were on 2 May. While there do not appear to be visible price adjustments around the announcement day on 3 June (dashed vertical line) or immediately afterwards, a week of price increases followed only later starting in mid-June. The most notable changes in prices can be observed, not surprisingly, around the date of the actual VAT change on 1 July (solid vertical line). Specifically, we can see that, beginning in the last week of June, the share of products whose prices are lower than on 2 May increases abruptly from 15% to around 30% within only a few days, with the largest number price adjustment happening on 1 July. What is more, there does not appear to be a contemporaneous increase in prices of other products.

At the beginning of 2021, that is, immediately after the VAT reduction was reversed, the share of products whose prices are lower than they were on 2 May started to decrease. However, the decrease is very small. By the end of March 2021, around 20% of REWE products were still cheaper than on 2 May 2020.

Figure 2: Dynamics of Retail Sales Prices since 2 May 2020

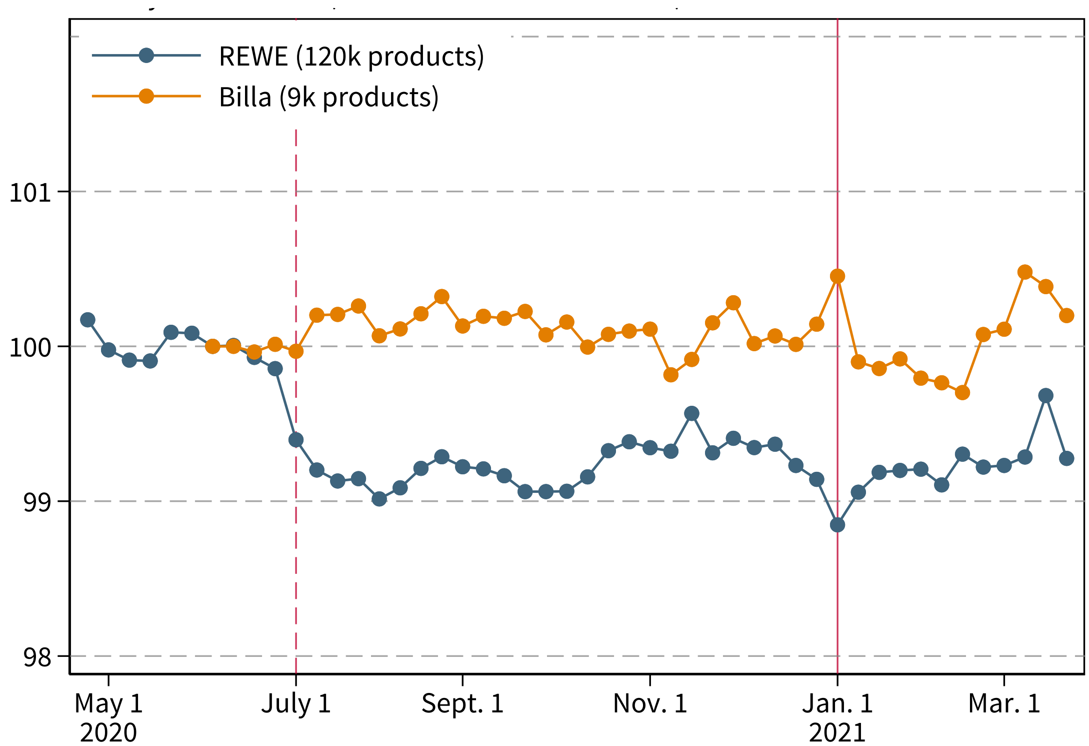


Notes: For each point in time indicated on the abscissa, the figure shows the share of REWE products (in %) whose prices are lower (green shaded area), higher (red shaded area), or the same (white area) compared to 2 May 2020. The dashed vertical line indicates the day of the announcement of the temporary VAT reduction (3 June 2020), the first solid vertical line the day of the VAT rate cut (1 July 2020), and the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). The number of products is 116,000.

What cannot be inferred from Figure (2) is the magnitude of the price effect of the temporary VAT reduction. For a first impression, we compare the development of daily supermarket prices across Germany and Austria in Figure (3). To facilitate the comparison, we transform the price for each single product into an index value, the basis of the index being the product's price on 4 June.

Figure (3) reveals that right at the time when the VAT rate cut in Germany became effective, the (relative) prices in German and Austrian supermarkets drifted 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. Strikingly, even after the German VAT rate cut was reversed on 1 January 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. Arguably, this finding is a first indication of an asymmetric price effect. The price reduction following the VAT rate cut in July 2020 appears to be larger than the price increase in response to the VAT rate hike in January 2021.

Figure 3: 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 dashed vertical dashed line indicates the day of the VAT rate cut (1 July 2020) and the solid vertical line the day of the reversal of the VAT rate cut (1 January 2021).

Note that in the weeks before and after the VAT reduction, the price trends in Austria almost perfectly match the German trend, suggesting that Austrian supermarket prices indeed represent an ideal counterfactual for the German prices.

3. 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.

3.1 Dynamics of the COVID-19 pandemic in Germany and Austria and (economic) policy measures

It is central to the identification strategy 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 we will argue in this section, 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.[7] Third, the Austrian stimulus package was announced less than three weeks after the German one.

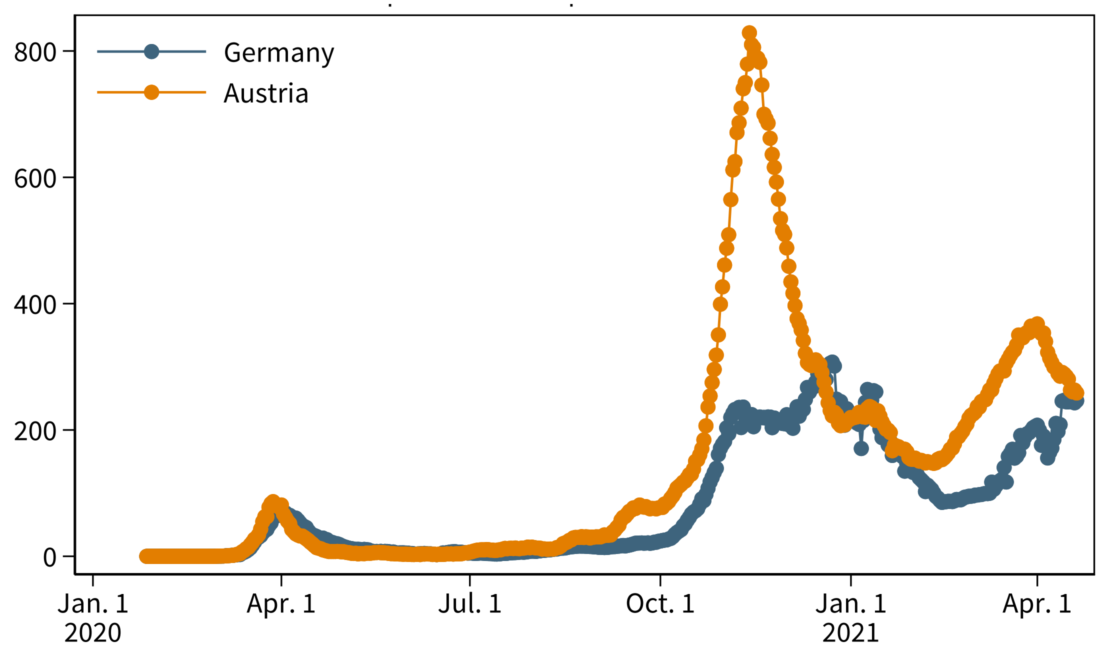
What started with few individual cases and locally restricted clusters of COVID-19 outbreaks in January and February turned into rapidly increasing infection numbers in early March in all parts of Germany and Austria with COVID-related deaths trailing by a few days (see Figures (4) and (5)). In response to this 'first wave' of the pandemic, which occurred simultaneously in Germany and Austria, both governments implemented a range of measures in mid-March that aimed at containing the spread of the coronavirus. These measures 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, such as constraints on the number of customers per square meter.[8]

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

7 Austria only reduced the VAT rate for hotel stays as well as for food and drinks served in hotels.

8 A detailed timeline of the main COVID-related events and policy measures taken in Germany and Austria can be found in Tables (2) and (3) of Appendix (A).

Figure 4: Development of COVID-19 Infections in Germany and Austria

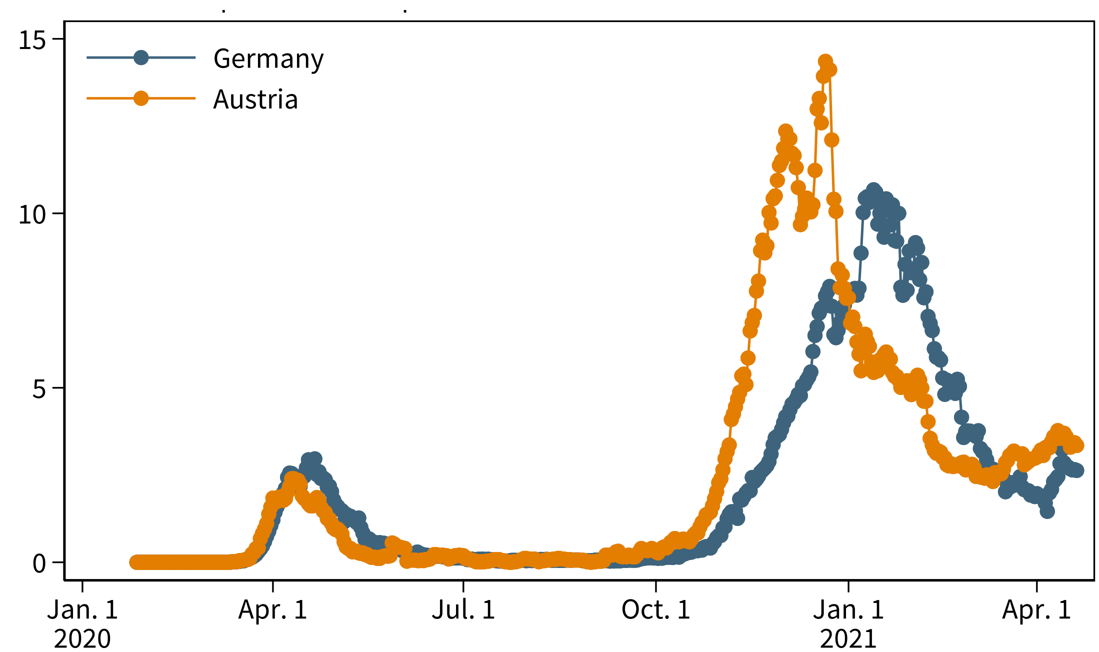


Notes: The figure shows the one-week moving averages of the daily number of COVID-19 infections per one million inhabitants. Data source: Our World in Data, COVID-19 Dataset, Series: new_cases_smoothed_per_million.

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 menues. 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, subject to meeting hygiene standards, and remained open for customers at all times in both countries.

The containment measures brought about significant output declines in both countries, particularly so in harder hit industries such as hospitality, tourism, and the entertainment sector. In order to mitigate the economic consequences for firms, their employees, and self-employed individuals, both governments set up various support programs that intended to stabilize aggregate demand and to support firms, among other things. As in the case of the containment measures, both stimulus packages were closely resembling each other in their main building blocks: loan provisions and credit guarantees to firms and self-employed affected by the plunge in revenues made the brunt of the stimulus programs and were implemented quickly in spring. Financial support for firms was complemented by partial or complete tax deferrals until next year and increased thresholds for loss-carrybacks in 2020 and 2021 for the purpose of income taxes and corporate profit

Figure 5: 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.

taxes. Similarly, outstanding social security payments could be deferred or paid in paid-in-installments. Another central support measure was to ease access to each country's short-term furlough scheme. The programs allow employers to reduce their employee's 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. The allowance is tax free and can be received for a total of 24 months under the current legislation. 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. In addition, a series of measures aimed at increasing disposable household incomes was adopted. For instance, households with children received one-time cash payouts in both countries: 360 euro per child under 18 years in Austria and 300 euro in Germany.

Thus, taken together, both countries moved closely together in terms of the timing of infection waves as well as prevention and stimulus measures. First, 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. Second, firms received government support in the form of liquidity provisions and were allowed to keep their production running. Last, private consumption has been stabilized in both countries, mostly through a generous expansion of short-time furlough schemes with roughly equally high replacement rates.

3.2 Price trends before the VAT reform

In our empirical approach, causal inference rests on the assumption that without 'treatment' (i.e., the VAT reduction), the development of the outcome variable (i.e., supermarket prices) would have been identical in the treatment and control group. A common trend in the outcome variable before treatment is considered as an indication of the validity of this assumption. The problem we are facing is that 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 to credibly test the validity of the common trend assumption. Moreover, during those three pre-reform weeks, prices may have already adjusted in anticipation of the reform.

To check whether Germany and Austria exhibited similar price trends before the announcement of the temporary VAT rate cut, we compare the development of the price indexes of different product groups across the two countries using official price statistics from Eurostat (products exempt from VAT are excluded). Figure (6) shows the weighted average realizations of the monthly price indexes for 168 product groups since January 2017.[9] In Figure (7), 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. The figures demonstrate that before the temporary VAT reduction, prices in Germany and Austria have developed very similarly. Any differences between the price indexes in Germany and Austria before the VAT reduction were only of minor size and not statistically significant, as Figures (15) and (16) of Appendix (B) demonstrate. This is also true for the months immediately before the temporary VAT rate change, suggesting that prices in Germany did not adjust in anticipation of the VAT rate cut. Thus, we are confident that Austrian supermarket prices represent a credible counterfactual for supermarket prices in Germany.

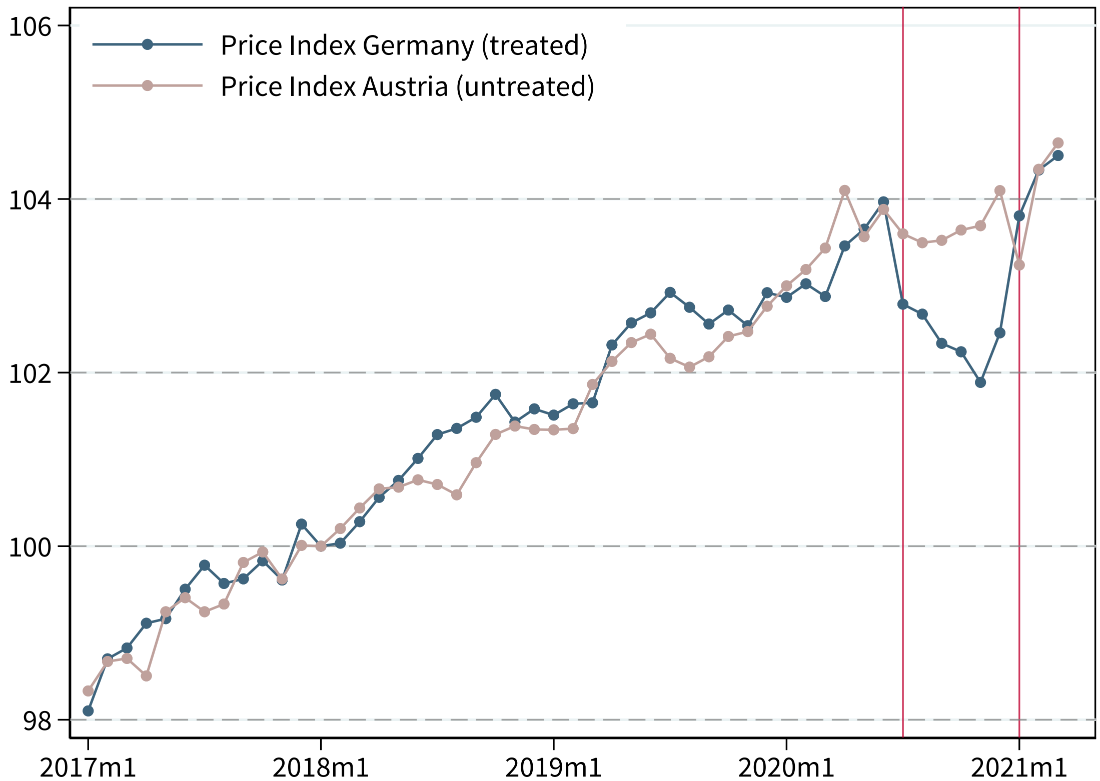
4. Price Effects of the Temporary VAT Rate Change

4.1 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 price effect of the temporary VAT change (Schmidheiny and Siegloch, 2020). Specifically,

9 We use the product group 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.

Figure 6: Price Development in Germany and Austria since 2017



Notes: The figure shows the average monthly price indexes for 168 product groups for Germany and Austria (base period: January 2018). The first solid vertical line indicates the month of the VAT rate cut (July 2020), the second solid vertical line the month of the reversal of the VAT rate cut (January 2021). Data source: Eurostat.

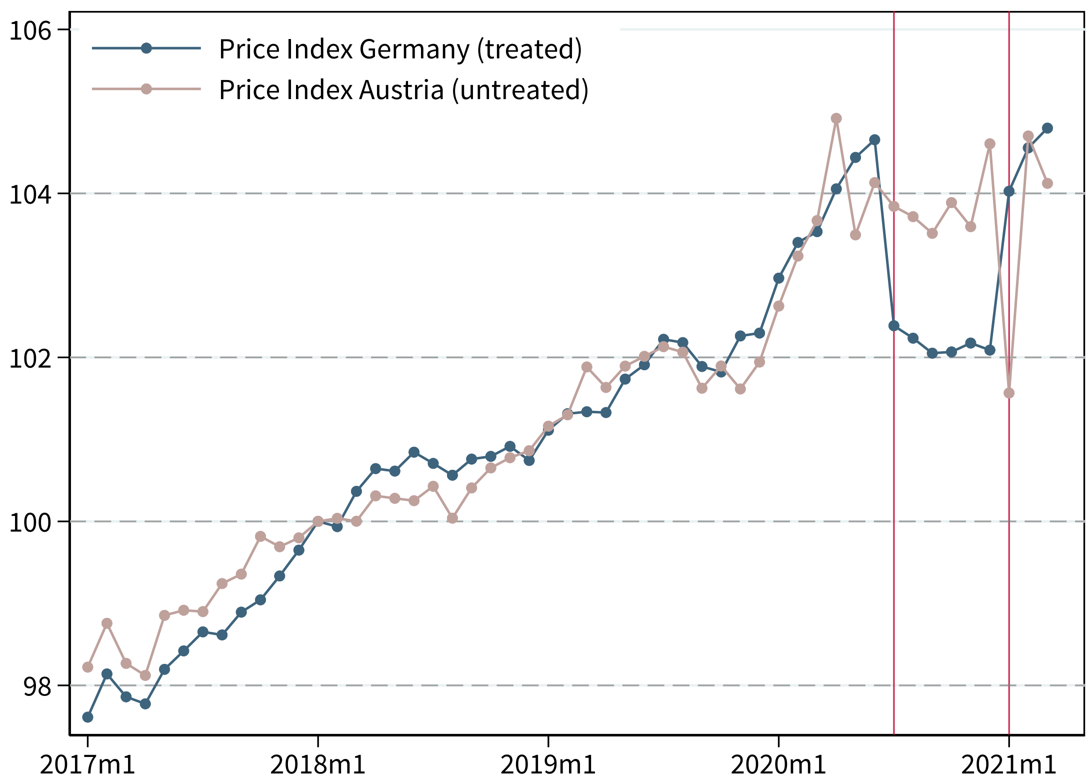
we estimate the following empirical model:

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

Index i refers to the 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).[10] All prices inlcude the VAT. $b_{i,w}^{j}$ is our event study indicator. We use two different sets of event study indicators. First, a set of dummy variables equal to one j weeks before/after the VAT reduction in case product i belongs to the assortment of REWE and not to Billa products. This approach provides estimates for week-specific relative price adjustments in response to the VAT rate changes. Second, a set of continuous variables measuring the

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

Figure 7: Price Development for Selected Product Groups in Germany and Austria since 2017



Notes: The figure shows the average monthly price indexes for selected product groups for Germany and Austria (base period: January 2018). The first solid vertical line indicates the month of the VAT rate cut (July 2020), the second solid vertical line the month of the reversal of the VAT rate cut (January 2021). Data source: Eurostat.

change in the VAT burden relative to the gross price of product i. This indicator is equal to 2.52% for products subject to the standard VAT rate (which was reduced from 19% to 16%) and to 1.87% for products subject to the reduced VAT rate (which was reduced from 7% to 5%). In this approach, the coefficient estimates of the event study indicators measure the pass-through rate of the temporary VAT reduction, i.e., the share of the VAT rate change that was passed on to consumers. 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. μ_i is a product-fixed effect that accounts for time-invariant product characteristics, and $\varepsilon_{i,w}$ is the residual error term. Standard errors are clustered at the 4-digit COICOP product class level, yielding 99 clusters. 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, that is, the week in which the VAT rate cut was announced. We weight the observations using the products groups' CPI weights (cf. Table (1)). Results for unweighted regressions are presented in Figures (17) and (18) of Appendix (B).

4.2 Results for the Baseline Specification

Figure (8) plots the coefficient estimates for the event dummy variables, Figure (9) for the continuous event study indicators. The shaded areas represent 95% confidence intervals. 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 fluctuations – remained at that level until VAT rates returned to their previous level (cf. Figure (8)). Figure (9) reveals that the price decrease of 1.3% corresponds to a pass-through rate of the VAT rate cut of roughly 70%. Consequently, 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 never fully caught up. I.e., even three months after the VAT rate cut was repealed, German supermarket prices were 0.5%–0.6% lower that they would have been without the tax cut. Thus, there is a pronounced 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. 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 indicate that the price change in response to the VAT rate hike was two times larger than the price change following the VAT rate cut.

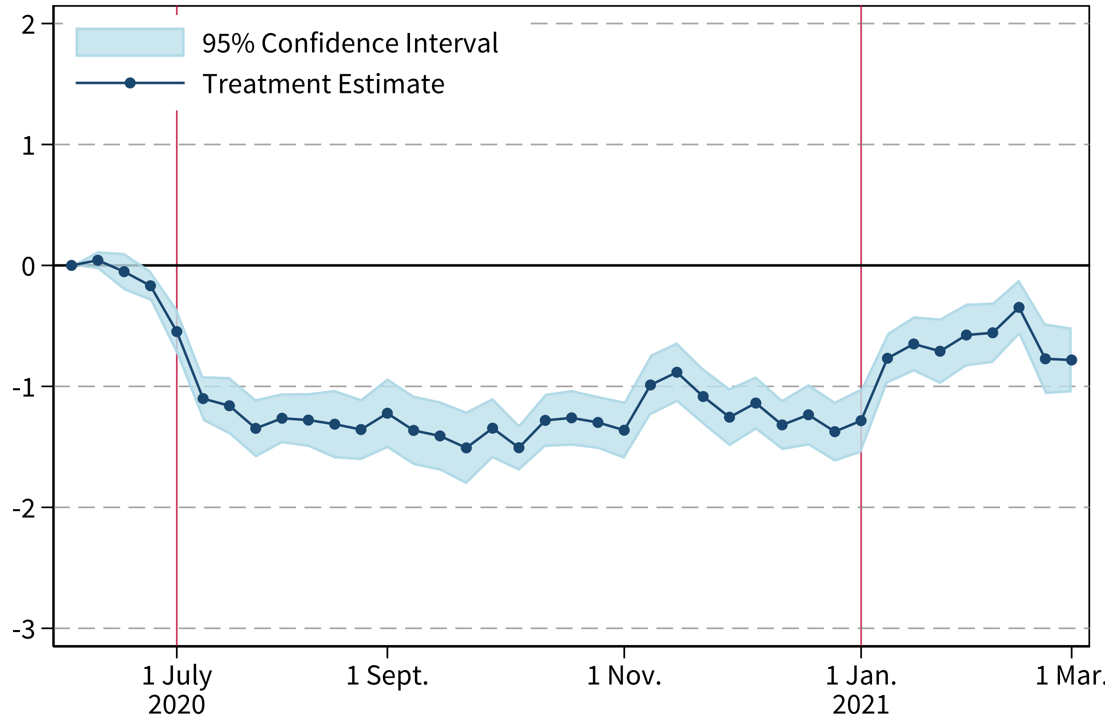
Figures (17) and (18) of Appendix (B) show the results for the unweighted estimations. The coefficients estimates of the event study indicators are virtually identical.

4.3 Results for Different Product Groups

Figures (10) to (12) 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 (1)) – food and non-alcoholic beverages (Figure (10)), alcoholic beverages and tobacco (Figure (11)), and cosmetic and hygiene products (Figure (12)).[11] 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

11 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 low. 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.

Figure 8: Results of Event Study Analysis (Event Dummies): Impact of the VAT Rate Cut on Prices



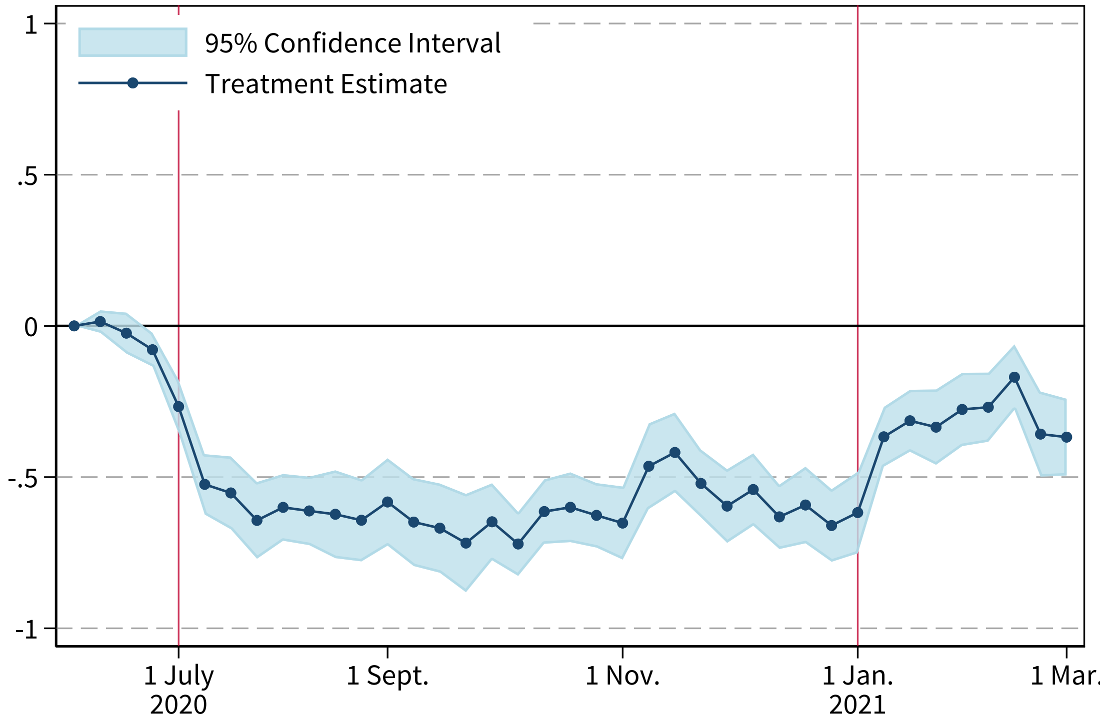
Notes: The figure shows the coefficient estimates for the event dummies along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 130,838, the number of clusters is 99.

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% to 30%. An 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.

5. The Role of Competition for the VAT Pass-Through

As the incidence of a tax depends on the relative elasticities of supply and demand, the market structure should be an important determinant of the VAT pass-through. In this section, we empirically analyze the relationship between the price effect of the VAT rate

Figure 9: Results of Event Study Analysis (Continuous Event Indicators): Pass-Through of the VAT Rate Cut to Prices



Notes: The figure shows the coefficient estimates for the continuous event indicators along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 130,838, the number of clusters is 99.

change and the degree of competition in a product market. Then, we rationalize our findings by introducing consumption taxes into the 'love of variety' model of consumption.

5.1 Estimation Strategy

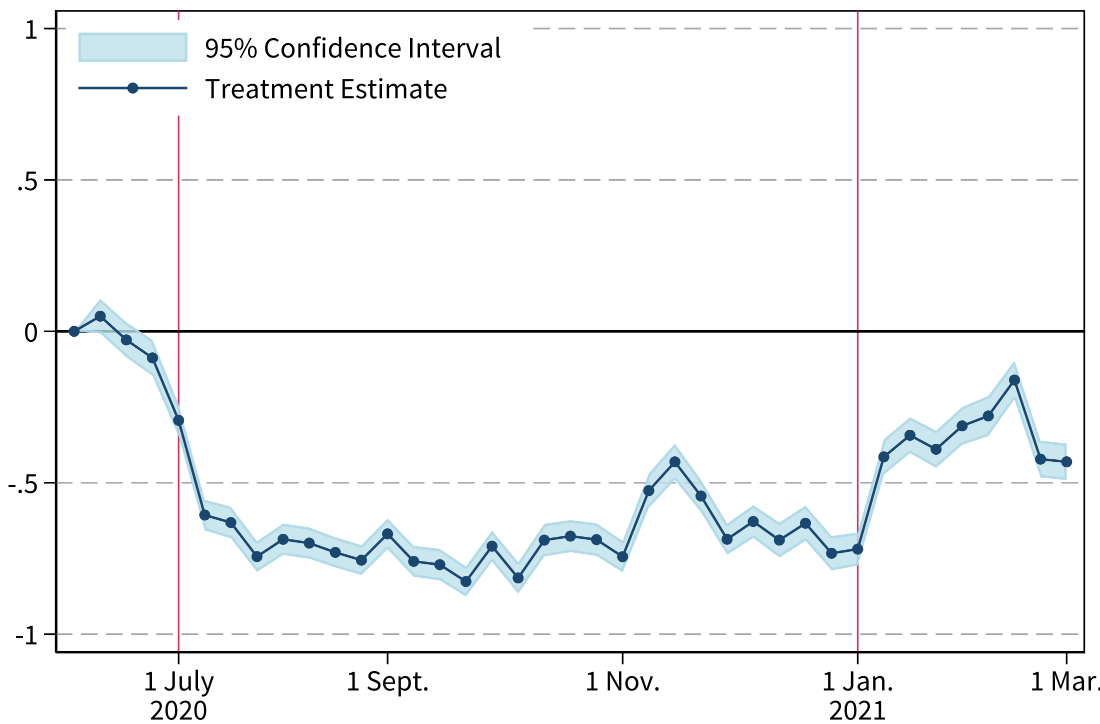
To estimate the relationship between the degree of competition in a product market and the magnitude of the price effect of the VAT rate cut and subsequent increase, we estimate the following empirical model using OLS:

$$y_{k,w} = \alpha_w + \tilde{\beta}_w \times log(brands_k) + \tilde{\varepsilon}_{k,w} \tag{2}$$

The dependent variable is a measure of the extent of the VAT pass-through for product category k.[12] We compute this measure by dividing the difference between the price index

12 Examples of product categories are noodles, rice, lemonades, shampoos, etc. I.e., we do not differentiate between different types of noodles, like penne pasta, spaghetti, and so on, since we consider products of the same group to be close substitutes.

Figure 10: The Pass-Through for Food and Non-alcoholic Beverages



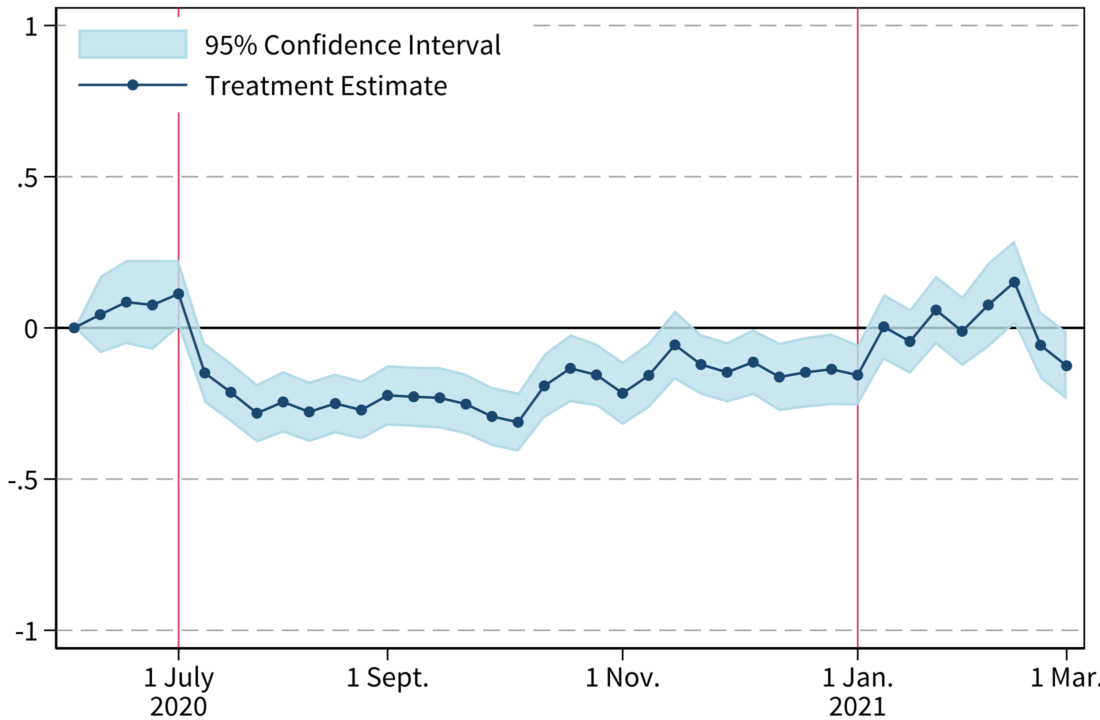
Notes: The figure shows the coefficient estimates for the continuous event indicators along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). White-robust standard errors are used. The number of products is 38,840.

of the REWE product and the price index of the corresponding BILLA product by the size of the VAT rate change (reduced vs. normal VAT rate). Our explanatory variable is a measure of the degree of competition in a product market, which we proxy by the number of brands in the REWE assortment offering the same product. We estimate Equation (2) seperately for each sample week to test whether the relationship between the VAT pass-through and the degree of competition varies over time.

5.2 Results

Figures (13) and (14) depict the relationship between the degree of competition and the extent of the VAT pass-through for selected sample weeks. Results for all weeks included in our sample period are shown in Figure (19) of Appendix (B). Figure (13) illustrates the relationship for selected weeks before and after the VAT rate cut on 1 July 2020, Figure (14) for selected weeks before and after the reversal. The single sub-figures show binned scatter plots along with linear regression lines for different points in time before/after the VAT rate changes. The regression results are based on Equation (2) (cf. Section (5.1)).

Figure 11: The Pass-Through for Alcoholic Beverages

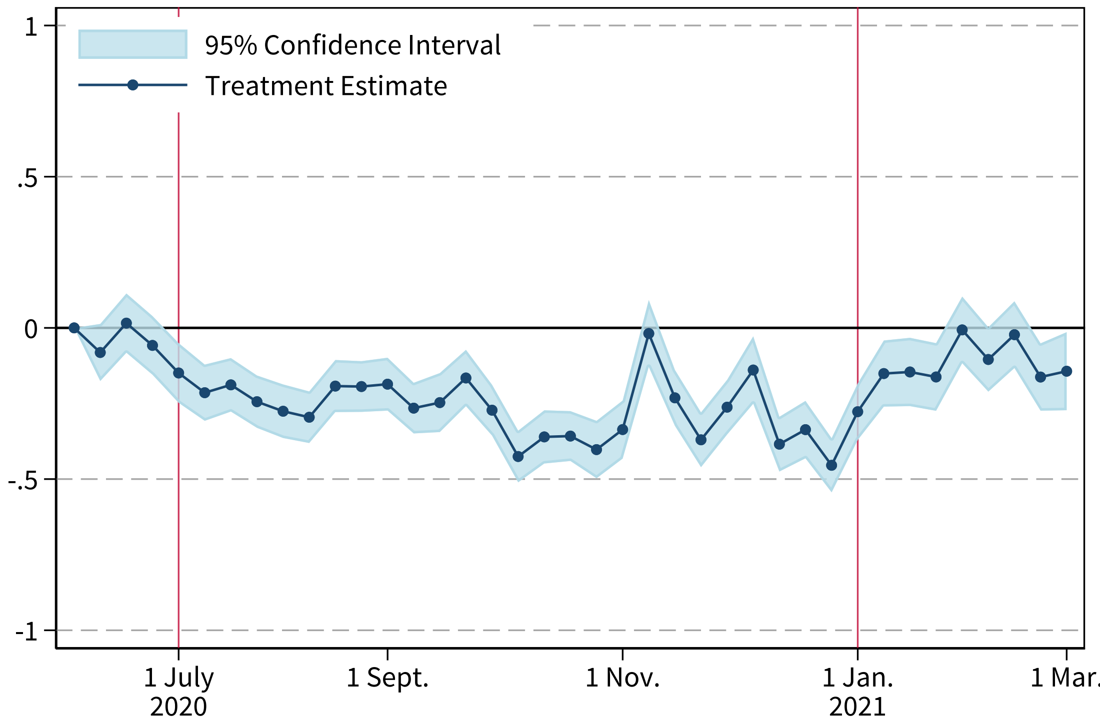


Notes: The figure shows the coefficient estimates for the continuous event indicators along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). White-robust standard errors are used. The number of products is 8,062.

In line with the findings from the event study analysis, Figure (13) indicates that prices decreased in the very week in which the VAT rate cut became effective (cf. sub-figure (b)). This can be seen from the fact that the regression line lies completely below the abscissa. Moreover, after the reduction of the VAT rate, we also see a robust negative (and statistically significant) association between the number of brands offering a certain product and the price change induced by the VAT reform, indicating that the price effect of the VAT reduction is larger, the larger the number of brands offering similar products is. In fact, the pass-through of the VAT rate cut for products supplied by many brands is close to 100%.

Mirroring the results depicted in Figure (9), prices started to increase again in the first week of January 2021, that is, the week in which VAT rates returned to their original levels (cf. sub-figure (c) of Figure (14)). This can be seen from the upward shift of the regression line. Interestingly, after VAT rates returned to their previous levels, the slope coefficients of the regression lines remain negative and statistically significant while the intercepts are close to zero. This indicates that the prices of products offered only by few suppliers returned to their original levels, whereas the prices of products supplied

Figure 12: The Pass-Through for Hygiene and Cosmetic Products



Notes: The figure shows the coefficient estimates for the continuous event indicators along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). White-robust standard errors are used. The number of products is 10,146.

by many producers remained lower than they were before the VAT rate cut. Thus, the asymmetric price response to the VAT rate cut and subsequent increase documented in Figure (13) appears to be driven by producers operating in markets characterized by a large variety of products. Those producers pass on the VAT rate cut in full to the consumers, but the VAT rate hike only in part.

5.3 Rationalizing Heterogeneous Pass-Through Rates

Since the market structure affects the elasticity of supply, it is not surprising that pass-through rates are related to the degree of competition in a product market. However, in general, the theory of tax incidence in imperfectly competitive markets does not generate unambiguous predictions about how the intensity of competition affects the degree to which taxes are shifted to buyers. In our empirical analysis, we observe that a smaller share of the VAT is shifted to consumers if the number of goods within a product group is smaller. How is this finding related to theoretical insights on tax shifting in imperfectly competitive markets?

One way of interpreting this result is through the lens of standard models of oligopolistic competition, where several firms offer similar goods and compete for buyers. These models generate no unambiguous prediction for how the number of competitors will affect the extent of tax shifting. If firms compete in quantities, a growing number of competitors will lead to equilibria with lower price markups on marginal costs and profits. But if they compete in prices, even a small number of competitors can lead to market equilibria where prices are equal to marginal costs and taxes are fully shifted to consumers. In general, though, tax shifting does not only depend on price markups in these models, but also on the curvature of the demand function (see e.g. Weyl and Fabinger (2013)).

Another way of thinking about tax shifting in supermarket retail is to use another model of imperfect competition, i.e., the 'love of variety' model pioneered by Helpman and Krugman (1985). It implies that consumers' utility increases if they can buy a wide variety of items within a product group. This is an appealing characterization of supermarket retail, where consumers like to be offered a wide range of groceries, drinks, personal care products, and other items. In this model, the link between tax shifting and the number of varieties offered is again ambiguous, but in a different way compared to the standard oligopoly models mentioned above. In the following, we develop the simplest possible version of the love of variety model which allows us to study tax shifting in product groups with different numbers of varieties.

Utility of the representative agent is given by the linear homogeneous utility function

$$U(L, G_1, G_2) = L^{(1-a_1-a_2)} G_1^{a_1} G_2^{a_2},$$

where a_1 and a_2 are parameters satisfying $a_1 + a_2 < 1$, L is leisure and $G_i = \left((\int_0^{n_i} x_{ij}^{\rho_i} dj) \right)^{1/\rho_i}$ for $i = \{1, 2\}$ and with $0 < \rho_i < 1$ is the subutility function describing the preferences of the household for consuming the n_i varieties of goods belonging to the product group i. We normalize the wage rate to unity and denote the household's time budget by T and the price of variety j in product group i by p_{ij}. The household's budget constraint can be written as

$$T - L = \int_0^{n_1} x_{1j} p_{1j} dj + \int_0^{n_2} x_{2j} p_{2j} dj.$$

Utility maximization implies that overall expenditure on goods of product group i is given by

$$e_i = \alpha_i (T - L) \quad \forall\, i = 1, 2.$$

Demand for variety j of product group i is given by the demand function

$$x_{ij} = \frac{e_i p_{ij}^{\sigma_i}}{\int_0^{n_i} p_{ij}^{1-\sigma_i} dj},$$

where $\sigma_i = 1/(1 - \rho_i)$ is the degree of substitutability. It is symmetric across all pairs of varieties within a product group but it may differ across product groups. Each product variety is produced by an individual firm. Each firm takes $\int_0^{n_i} p_{ij}^{1-\sigma_i} dj$ as given and thus faces an isoelastic demand function which can be expressed as

$$x_{ij} = \delta_i p_{ij}^{-\sigma_i},$$

where $\delta_i = e_i / \int_0^{n_i} p_{ij}^{1-\sigma_i} dj$.

Profit of the firm producing variety j in product group i is given by

$$\pi_{ij} = p_{ij}(1-t)x_{ij} - c(x_{ij}) - F = p_{ij}(1-t)\delta_i p_{ij}^{-\sigma_i} - c(x_{ij}) - F.$$

F is a fixed cost and t is the VAT rate. Profit maximization yields

$$p_{ij}(1-t) = \frac{c'(x_{ij})}{1 - 1/\sigma_i}. \tag{3}$$

Note that consumers spend the budget e_i they devote to each product group evenly across varieties within the group, so that the prices of the varieties are identical in equilibrium.

In the long term, the equilibrium number of varieties in each product group n_i is determined by the zero profit condition $\pi_{ij} = 0$, which regulates entry and exit of firms. Using the result that prices of varieties within each product group are symmetric, we can express the zero profit condition as

$$\frac{e_i}{n_i}(1-t) - c\left(\frac{e_i}{p_i n_i}\right) - F = 0 \quad \forall\, i = 1, 2 \tag{4}$$

and the pricing condition in Equation (3) as

$$p_i(1-t) = \frac{c'\left(\frac{e_i}{p_i n_i}\right)}{1 - 1/\sigma_i} \quad \forall\, i = 1, 2. \tag{5}$$

Equations (4) and (5) simultaneously determine p_i and n_i for given values of the VAT rate t, the fixed cost F, and σ_i.[13]

A key property of this model is that fewer varieties are offered in product groups where the varieties are closer substitutes and where fixed costs are higher. Higher taxes also reduce the number of varieties.

The focus of our analysis is on the short-term price effects of a temporary change in the tax rate. To study this, we abstract from firm entry and exit. We thus take the number of varieties in each product group as given and focus on price setting as described by Equation (5). What does this model imply for the shifting of the VAT to consumers? Differentiating Equation (5) and making some rearrangements yields

$$\frac{dp_{ij}}{dt} = \frac{c'(x_{ij})}{(1-t)(1-1/\sigma_i) + c''(x_{ij})x_{ij}/p_{ij}} = \frac{p_{ij}}{1+\mu_i}, \tag{6}$$

13 Also note that labour supply and, hence, overall consumer spending on each product group e_i is determined by the parameters of the utility function a_1 and a_2, and the time budget T, and therefore unaffected by changes in either t, F, or σ_i.

where we have used that, in equilibrium,

$$x_{ij} = \frac{e_i p_{ij}^{\sigma_i}}{\int_0^{n_i} p_{ij}^{1-\sigma_i} dj} = \frac{e_i}{n_i p_i}$$

and

$$\mu_i = \frac{c''(x_{ij})x_{ij}}{c'(x_{ij})} > 0$$

is the elasticity of the marginal cost curve. Note that Equation (6) implies

$$\frac{dp_{ij}}{dt}\frac{1}{p_{ij}} = \frac{1}{1+\mu_i}.$$

Interestingly, if the marginal cost curve is interpreted as the inverse supply curve, the right hand side of Equation (6) implies that a larger supply elasticity increases the share of the burden shifted to consumers. This is similar to the case of competitive product markets; the difference is that the demand elasticity does not emerge in the formula for the price change. This is because the price is set as a markup on marginal costs including taxes. The extent of tax shifting depends on the size of this markup, which in turn depends on μ_i.

How is the equilibrium value of μ_i related to the number of varieties offered within a product group? Note that we are now interested in the long-term equilibrium value of μ_i, which is determined by Equation (4) and (5), because this is from where the tax change starts. Since our model allows for different cost functions across product groups, the relationship between the number of varieties and the shifting of the VAT is, in general, ambiguous.

In the special case of isoelastic marginal cost curves μ_i is a constant, so that the shifting does not depend on n_i. But it is straightforward to find examples where the shifting is smaller in product groups with fewer varieties. Consider the case of a quadratic cost function of the type $c(x) = ax + 1/2bx^2$. In this case, the equilibrium value of the elasticity of the marginal cost curve can be expressed as

$$\mu_i = \frac{b}{b + \frac{ap_i(1-t)}{F_i\sigma_i}} \quad \forall\, i = 1, 2. \tag{7}$$

If $\sigma_1 > \sigma_2$, it follows that $p_1 < p_2$ and $n_1 < n_2$.[14]. Then, Equation (7) implies $\mu_1 > \mu_2$. In this case, stronger substitutability of varieties within product group 1 depresses prices and reduces the incentives to create more varieties. Each individual firm produces higher quantities and exhibits a higher elasticity of the marginal cost. This implies that a smaller share of the tax burden is shifted to consumers than in product group 2, where the number of varieties is larger.

14 The derivation is shown in Appendix (C)

6. Conclusion

On 3 June, 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 data set covering on average 190,000 product prices per day.

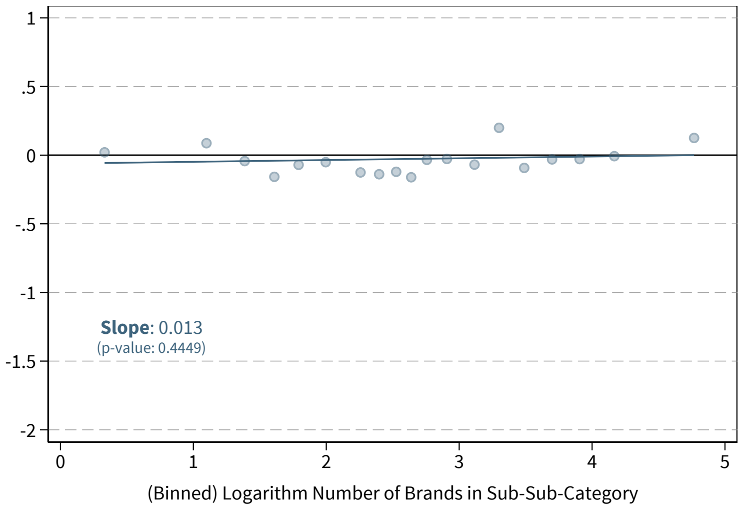
The results of our analysis indicate an asymmetric price response to the temporary VAT rate cut. After the reduction of VAT rates, we observe a decline in prices of around 1.3%, suggesting that roughly 70% of the tax cut was passed on to consumers. This finding is well in line with results presented in other studies, which also conclude that VAT rate cuts are only partially passed on (Benzarti and Carloni, 2019; Harju et al., 2018; Crossley et al., 2014). However, after VAT rates returned to their original levels in January 2021, German supermarket prices remained notably lower than they were before the VAT rate cut. On average, the price reduction in response to the VAT rate hike is only half the size of the price decrease in response to the VAT rate cut. This result stands in contrast to the finding by Benzarti et al. (2020). Using a VAT rate cut for hairdressing services in Finland and a subsequent VAT increase happening five years later, the authors find that the price increase in response to an increase in the VAT rate was double the size of the price decline following the VAT rate reduction.

Another interesting finding that we obtain is that the pass-through of the VAT is related to the number of varieties within product groups. Our results suggest that the price decrease following the VAT rate cut in July is less pronounced for products offered by only few suppliers and more pronounced for products offered by many suppliers. This finding can be rationalized by introducing a consumption tax into the 'love of variety' model proposed by Helpman and Krugman (1985). After the reversal of the VAT rate cut, prices went back to the pre-reform level in product groups with fewer varieties, while they remained notably lower in markets with more products.

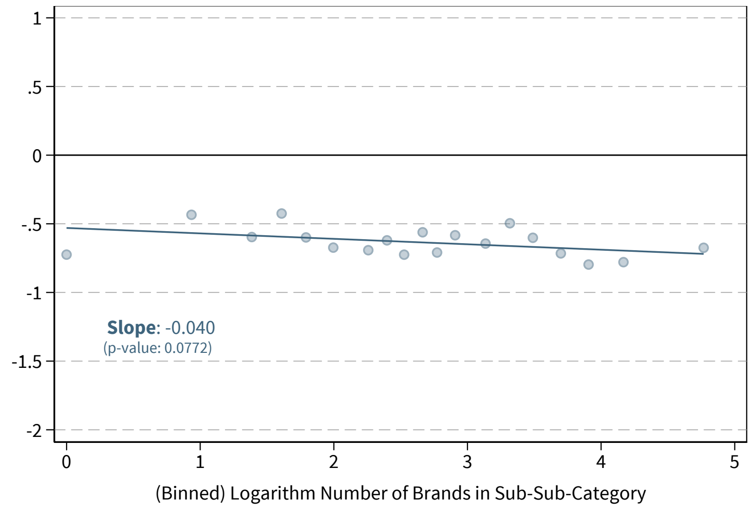
Note that our analysis covers only three months after VAT rates returned to their original levels. It cannot be ruled out that the price reduction in German supermarket retail following the temporary VAT rate cut will be fully revoked with a delay. We are therefore curious to see how supermarket prices will develop in Germany in the future.

Figure 13: The Pass-Through of the Temporary VAT Rate Cut as a Function of Competitive Pressure around the VAT Rate Cut in June 2020

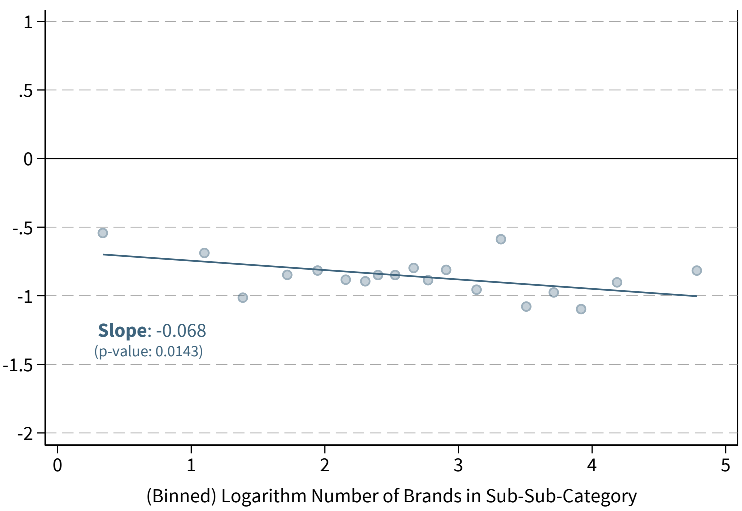
(a) 3 Weeks before Tax Cut



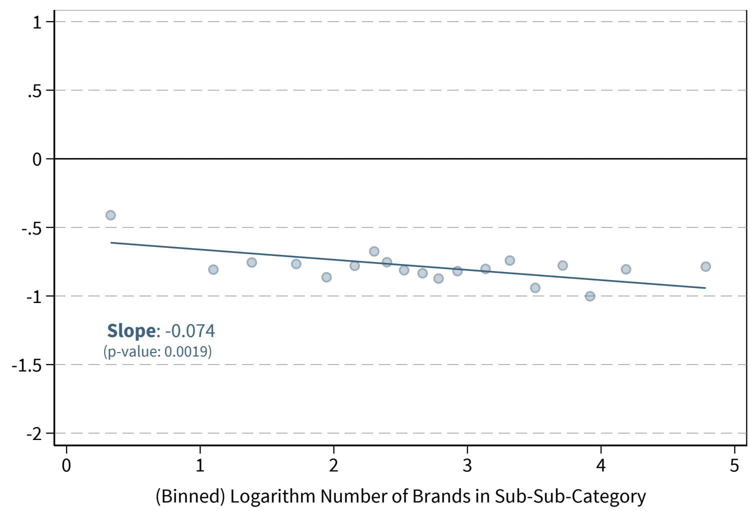
(b) 0 Weeks after Tax Cut/26 Weeks before Reversal



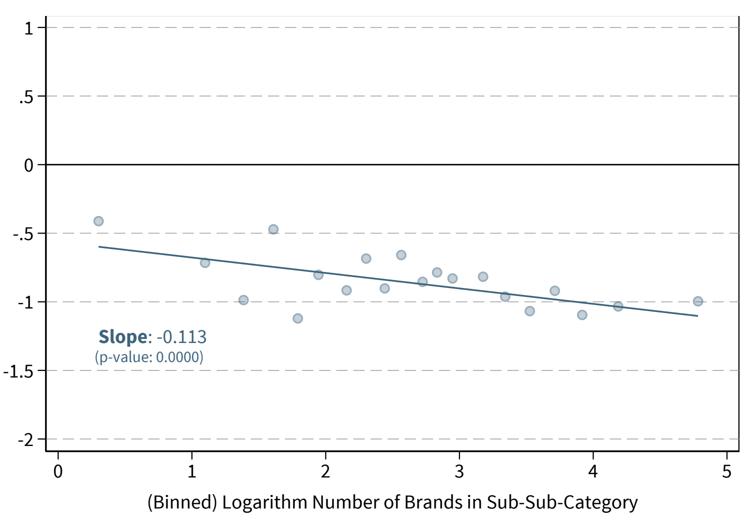
(c) 4 Weeks after Tax Cut/22 Weeks before Reversal



(d) 8 Weeks after Tax Cut/18 Weeks before Reversal



(e) 12 Weeks after Tax Cut/14 Weeks before Reversal



(f) 16 Weeks after Tax Cut/10 Weeks before Reversal

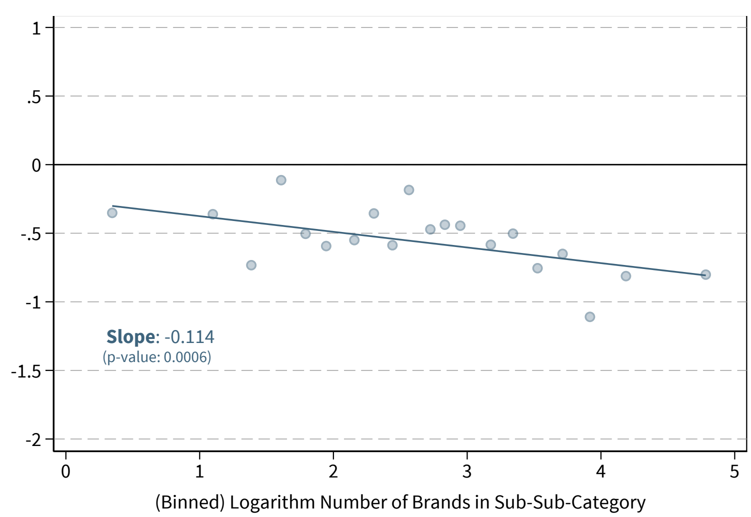
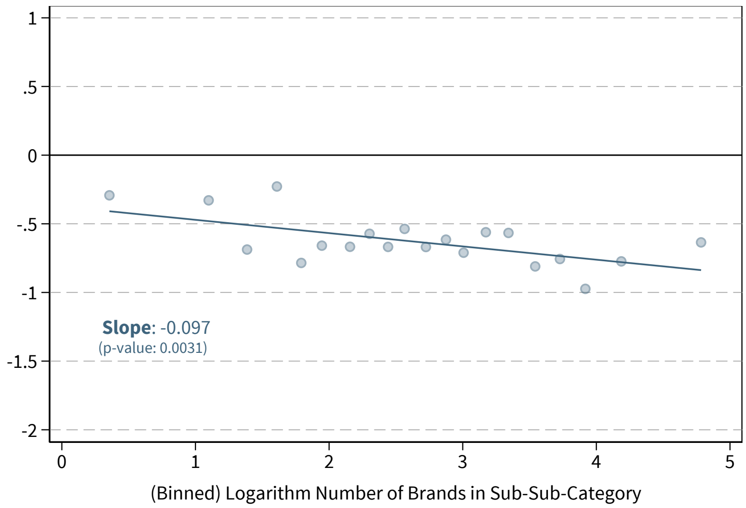
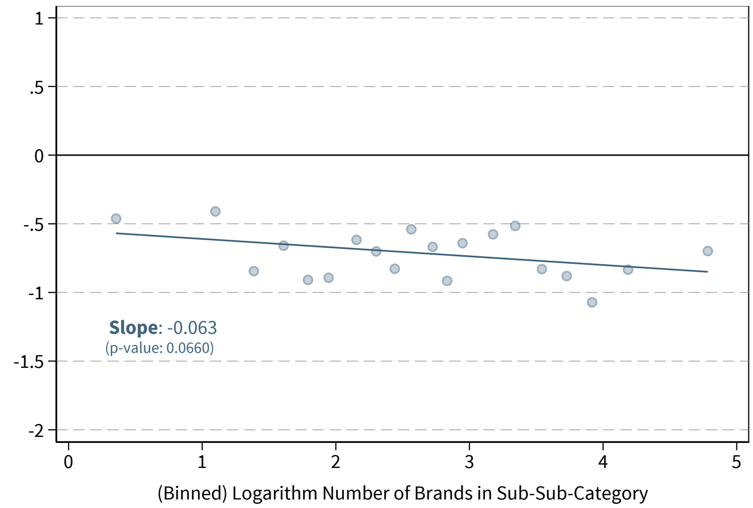


Figure 14: The Pass-Through of the Temporary VAT Rate Cut as a Function of Competitive Pressure around the VAT Rate Hike in January 2021

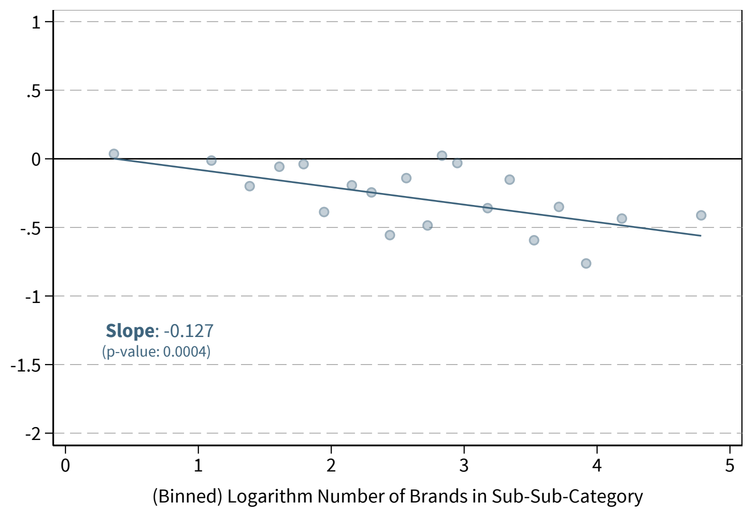
(a) 23 Weeks after Tax Cut/3 Weeks before Reversal



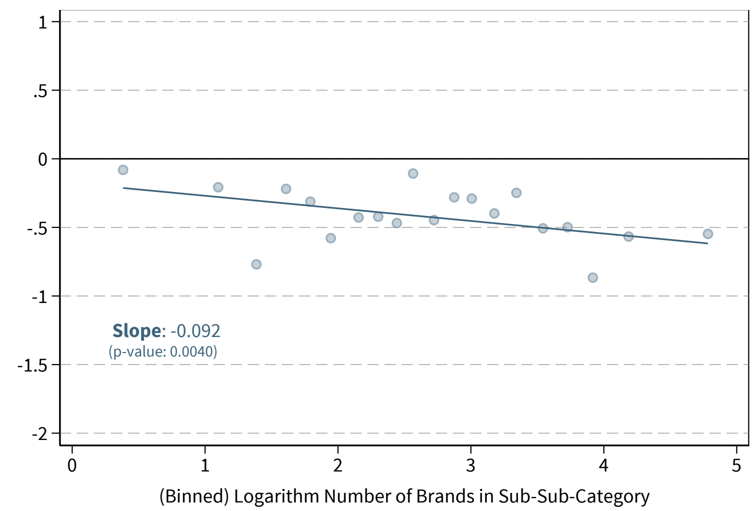
(b) 25 Weeks after Tax Cut/1 Week before Reversal



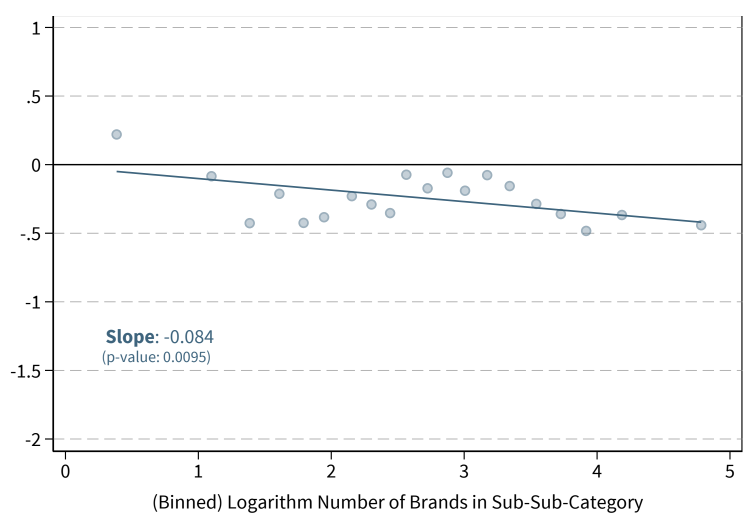
(c) 1 Week after Tax Cut Reversal



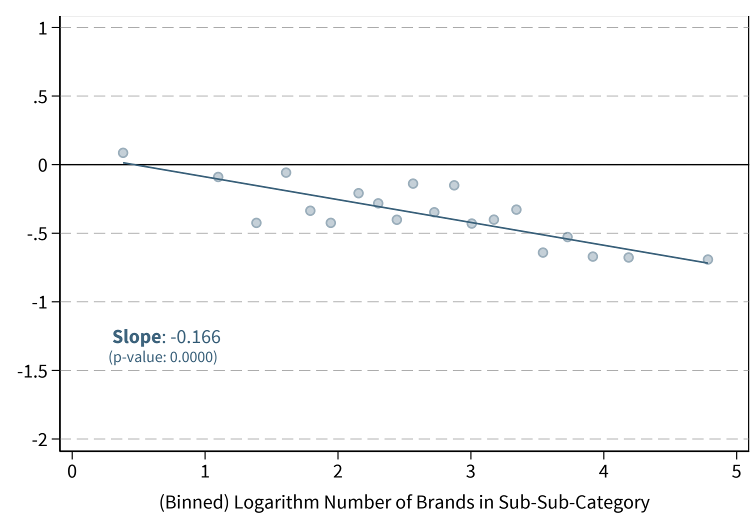
(d) 3 Weeks after Tax Cut Reversal



(e) 5 Weeks after Tax Cut Reversal



(f) 7 Weeks after Tax Cut Reversal



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Appendix A. Corona-related policy measures in Germany and Austria

Table 2: History of Main COVID-related Events and Containment Measures in Germany (Source: Official communiques of the German Government)

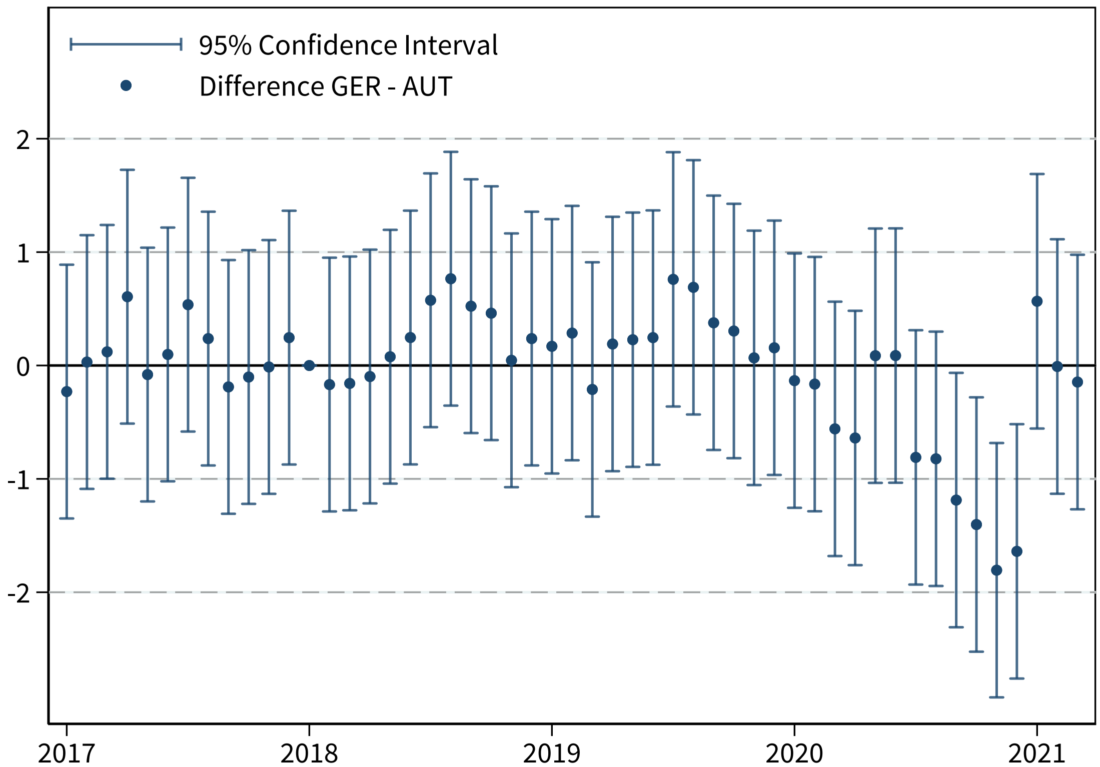
Jan. 2020	01/27: First confirmed COVID-19 case in Bavaria
Mar. 2020	03/01: Facilitated access to short-term working scheme ('Kurzarbeit')
	03/10: Events with more than 1,000 participants banned (recommendation)
	03/16: First lockdown: Closure of borders with France, Switzerland, Austria, Denmark and 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 1.5m social distancing mandatory in public
Apr. 2020	04/20: Re-opening of retail (up to 800m^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 1 January 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 800m^2 only one customer per 20m^2 (instead of 10m^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 8 March

Table 3: History of Main COVID-related Events and Containment Measures in Austria (Source: Official communiques of the Austrian Government)

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 400m^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 10m^2
	05/15: Re-opening of restaurants
	05/30: Removal of restriction that shops can only serve one customer per 10m^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 7 December: 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 10m^2)
Dec. 2020	12/26: Third ‘Hard Lockdown’ until 7 February 2021
Febr. 2021	02/08: Re-opening of retail (up to one customer per 20m^2), schools and cultural venues, e.g. museums. Contact-intensive services, e.g. hair dressing salons, require negative COVID-test.

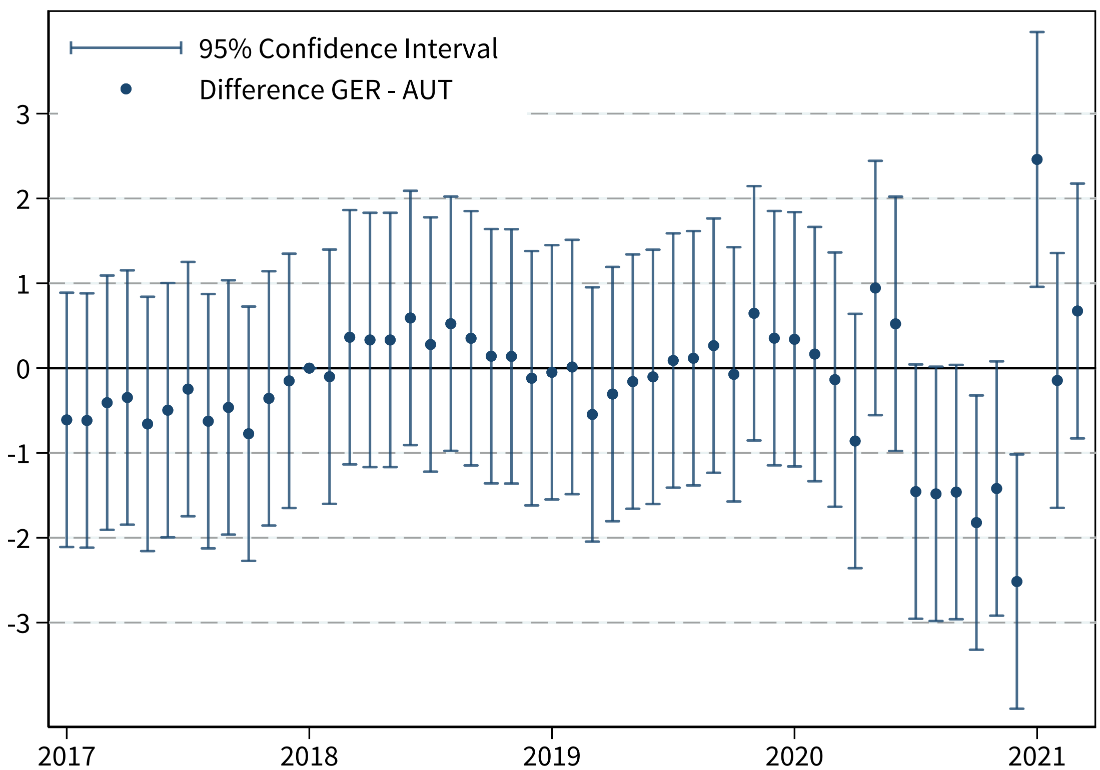
Appendix B. Additional Figures

Figure 15: Differences between Prices in Germany and Austria since 2017



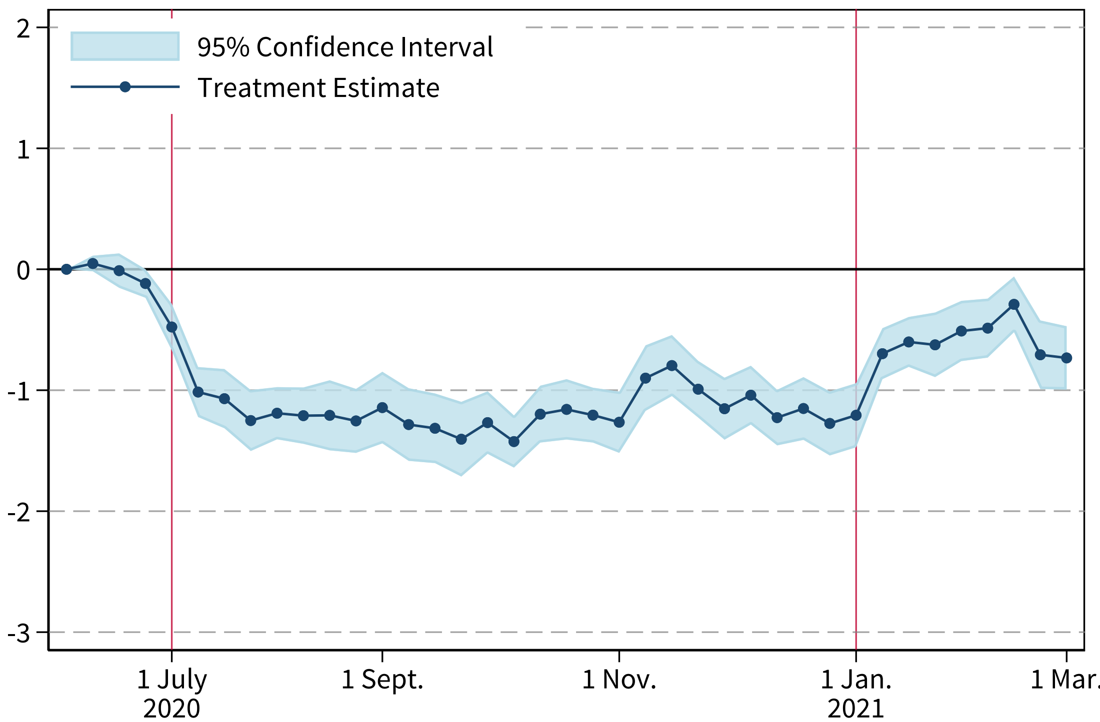
Notes: The figure shows the absolute difference between the average monthly price indexes for selected product groups across Germany and Austria. The whiskers indicate 95% confidence intervals. Data source: Eurostat.

Figure 16: Differences between Prices for Selected Product Groups in Germany and Austria since 2017



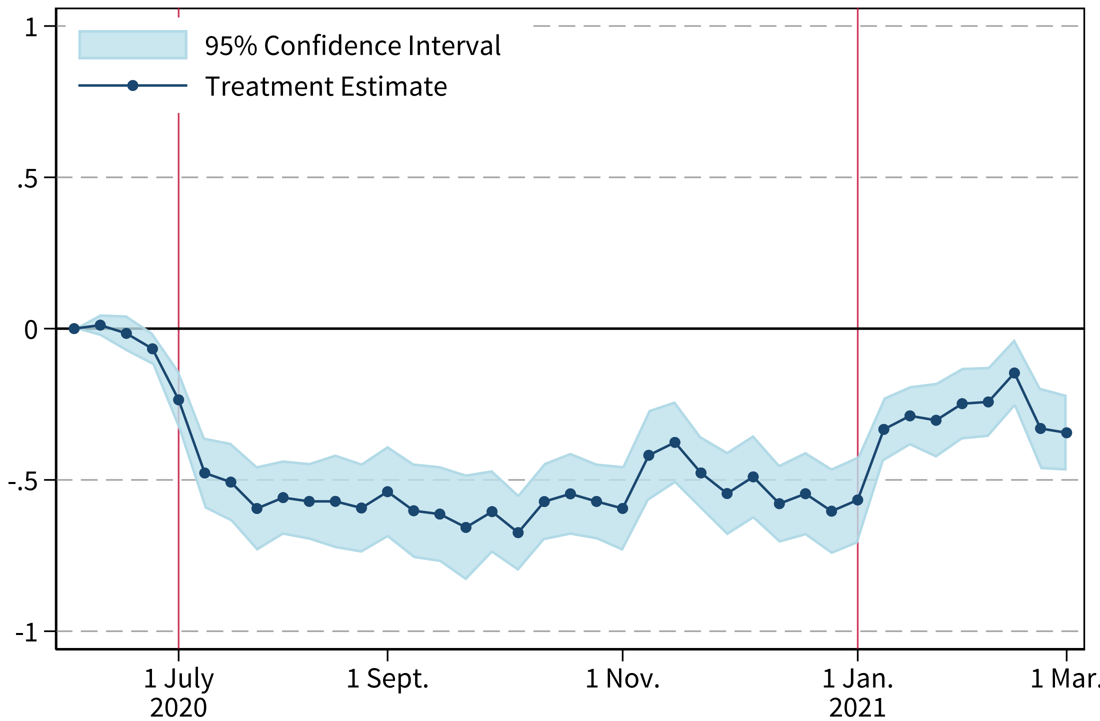
Notes: The figure shows the absolute difference between the average monthly price indexes for 165 product groups across Germany and Austria. The whiskers indicate 95% confidence intervals. Data source: Eurostat.

Figure 17: Results of Event Study Analysis (Event Dummies, Unweighted Regression): Impact of the VAT Rate Cut on Prices



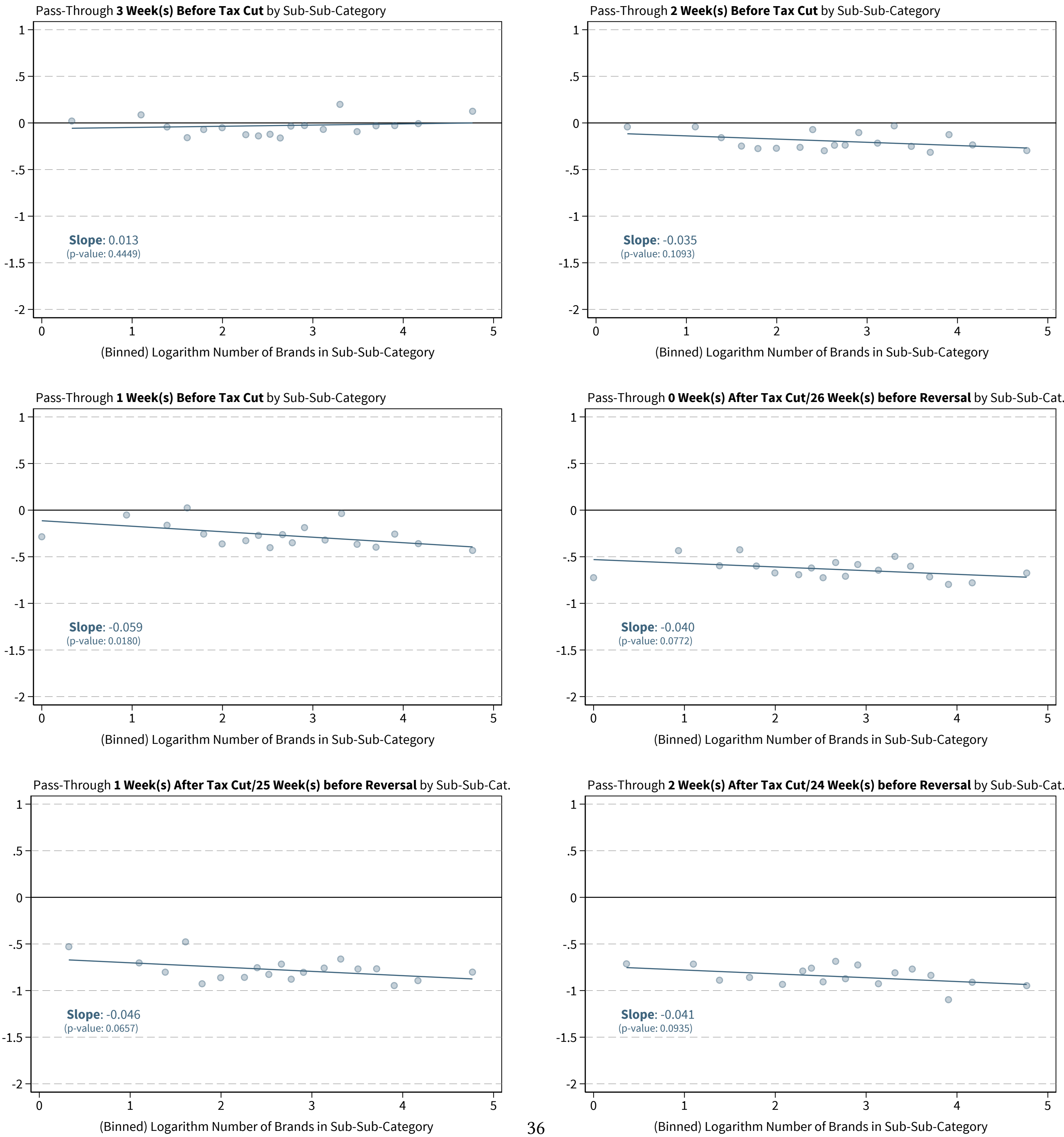
Notes: The figure shows the coefficient estimates for the event dummies along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 130,838, the number of clusters is 99.

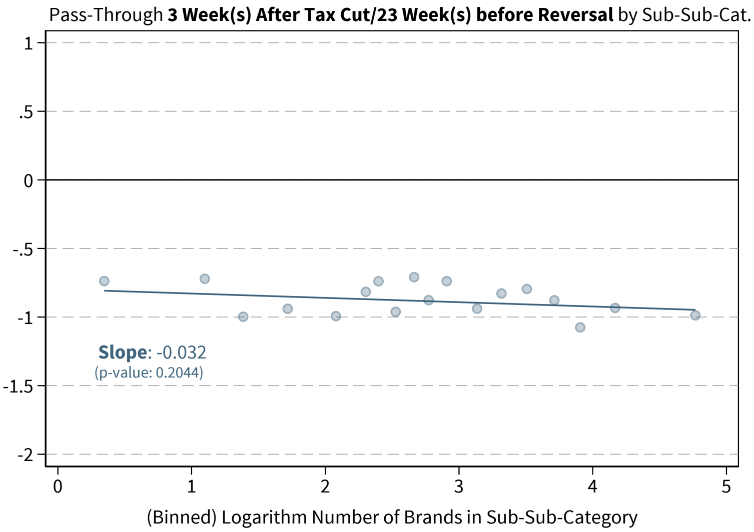
Figure 18: Results of Event Study Analysis (Continuous Event Indicators, Unweighted Regression): Pass-Through of the VAT Rate Cut to Prices

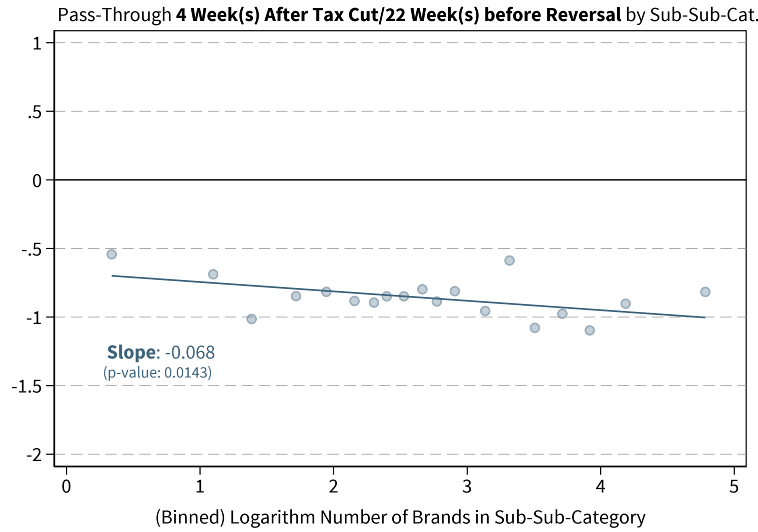


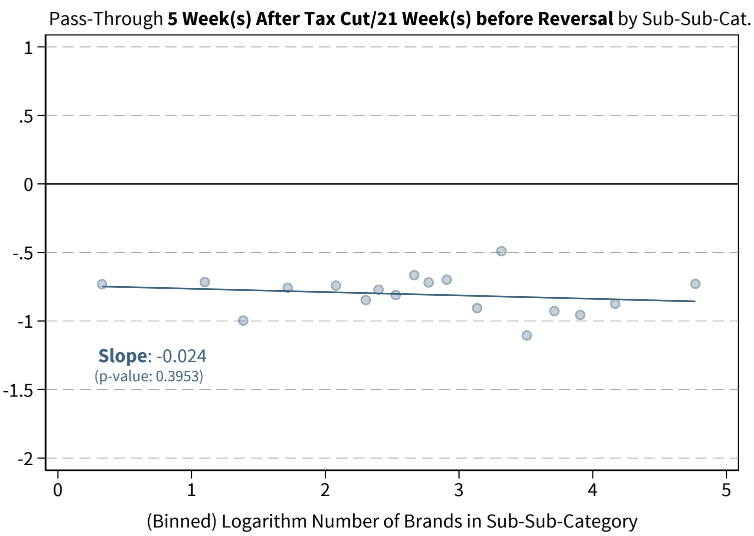
Notes: The figure shows the coefficient estimates for the continuous event indicators along with the 95% confidence intervals. Results are based on Equation (1). The first solid vertical line indicates the day of the VAT rate cut (1 July 2020), the second solid vertical line the day of the reversal of the VAT rate cut (1 January 2021). Standard errors are clustered at the product class level (COICOP 4-digit level). The number of products is 130,838, the number of clusters is 99.

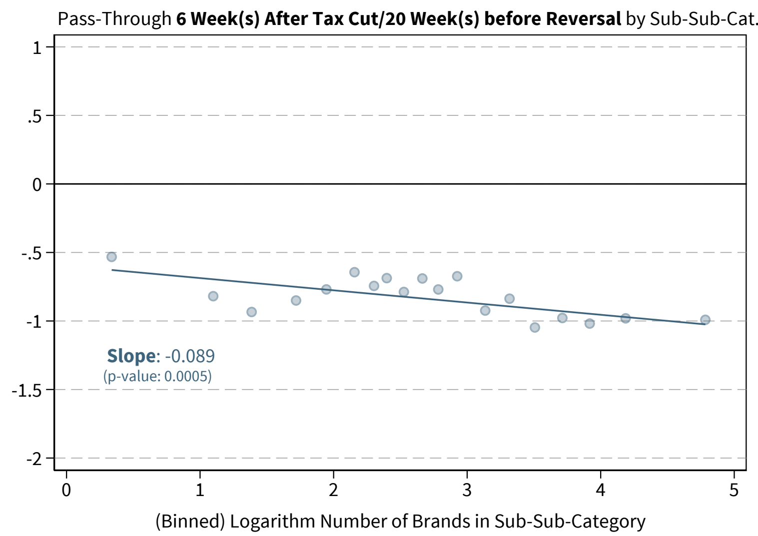
Figure 19: The Pass-Through of the Temporary VAT Rate Cut as a Function of Competitive Pressure

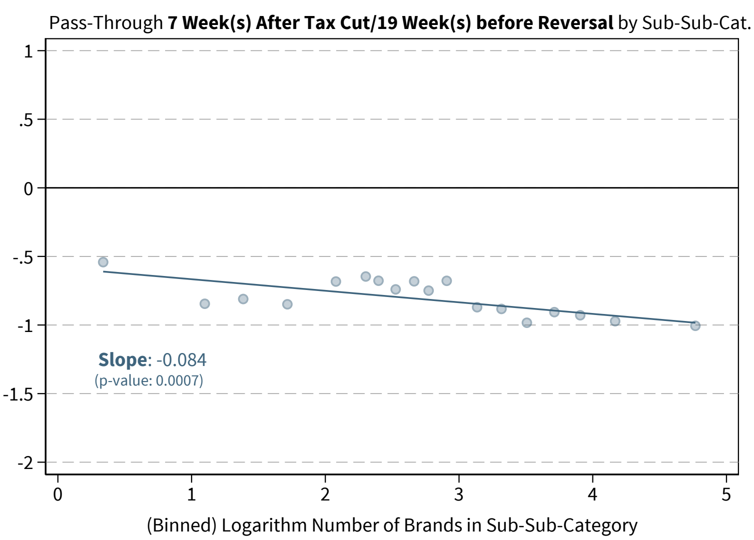


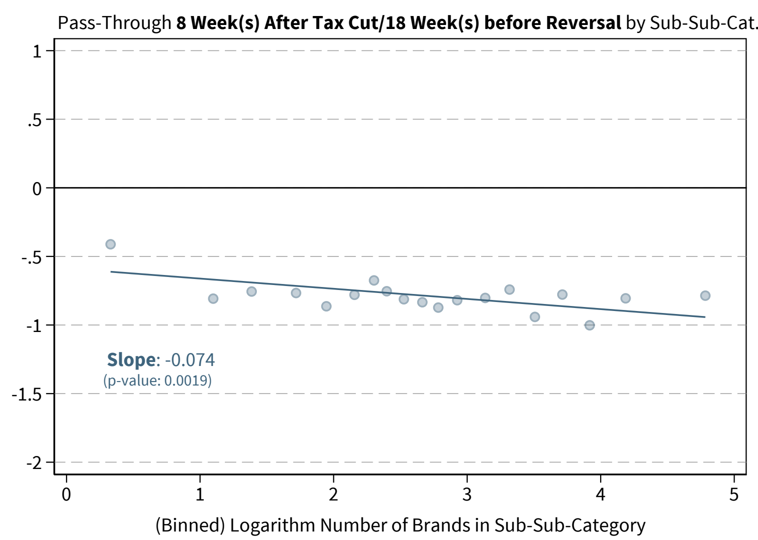

Pass-Through **3 Week(s) After Tax Cut/23 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.032
(p-value: 0.2044)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

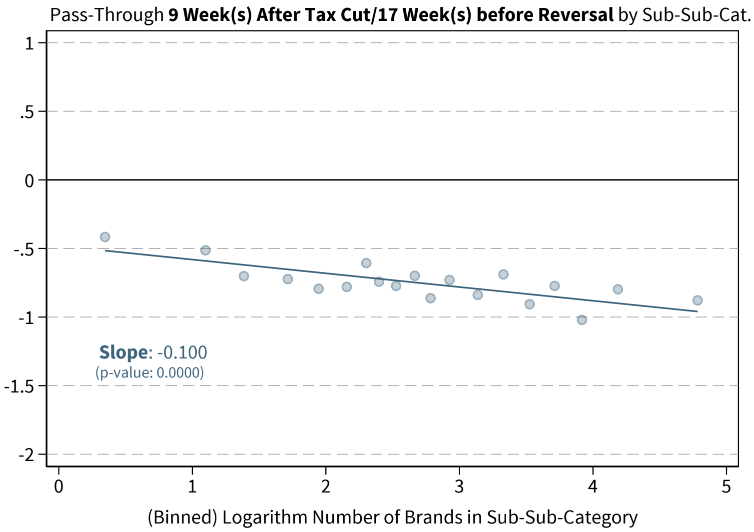

Pass-Through **4 Week(s) After Tax Cut/22 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.068
(p-value: 0.0143)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

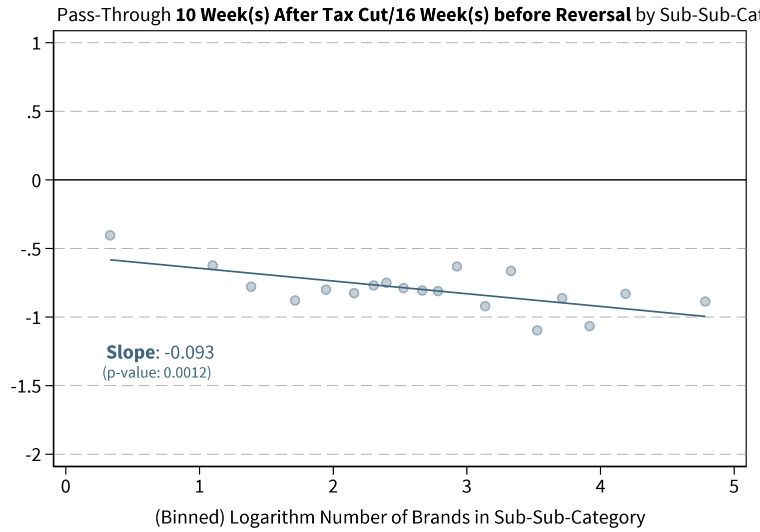

Pass-Through **5 Week(s) After Tax Cut/21 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.024
(p-value: 0.3953)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

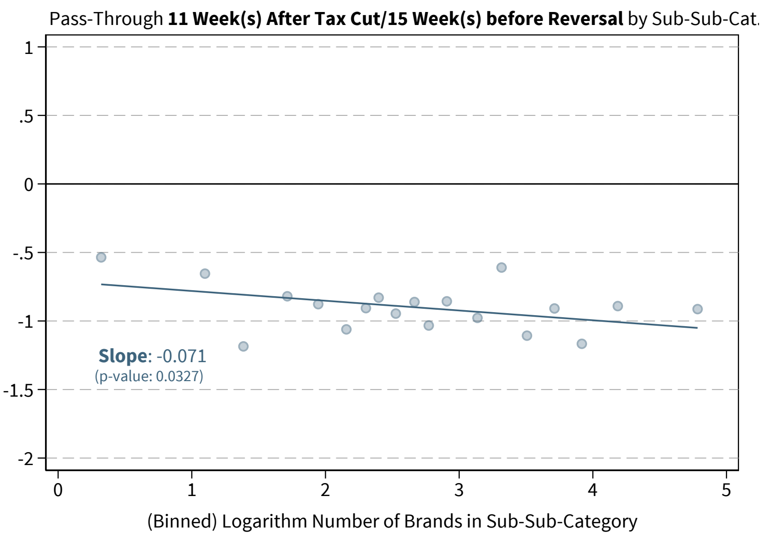

Pass-Through **6 Week(s) After Tax Cut/20 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.089
(p-value: 0.0005)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

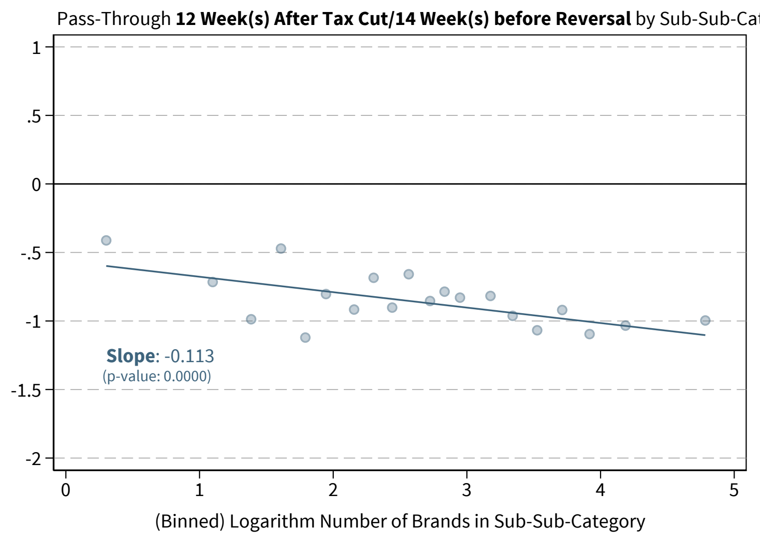

Pass-Through **7 Week(s) After Tax Cut/19 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.084
(p-value: 0.0007)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

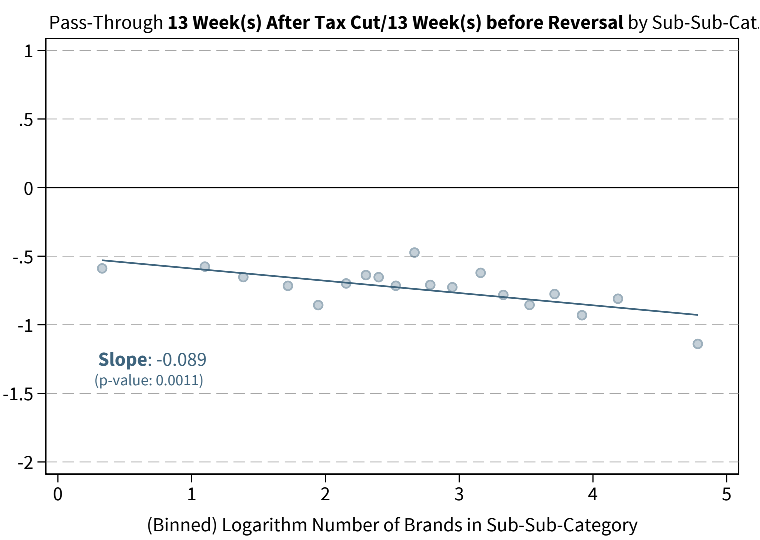

Pass-Through **8 Week(s) After Tax Cut/18 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.074
(p-value: 0.0019)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

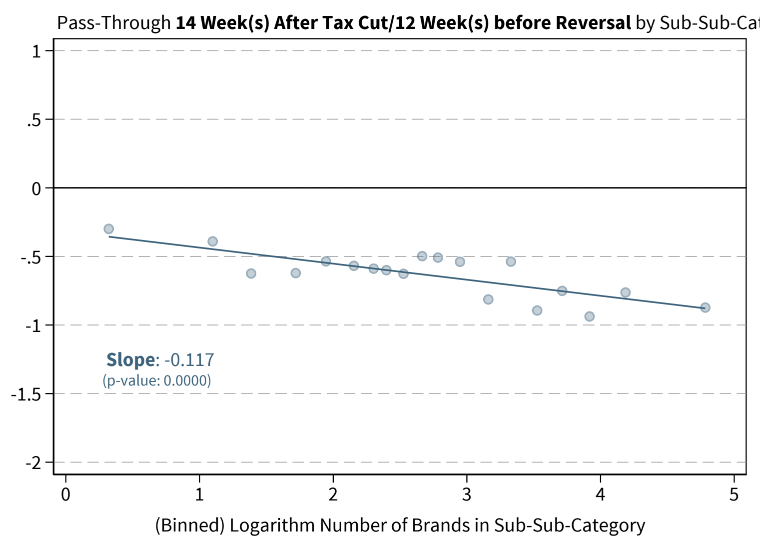

Pass-Through **9 Week(s) After Tax Cut/17 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.100
(p-value: 0.0000)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

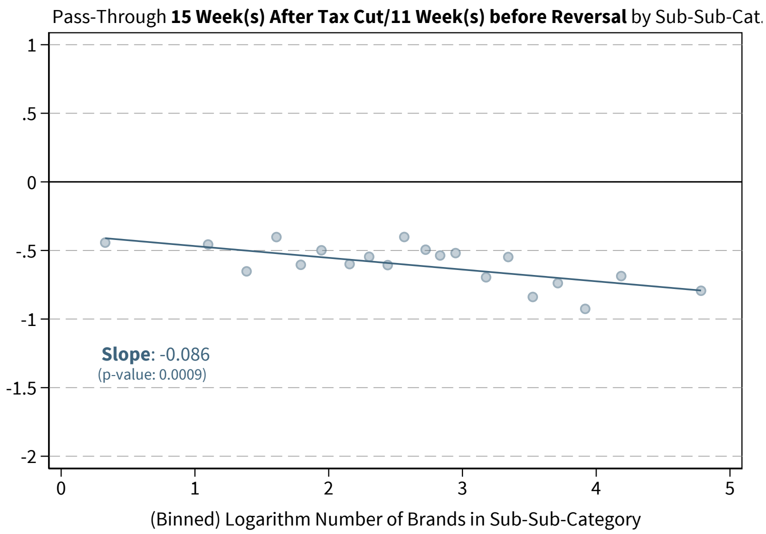

Pass-Through **10 Week(s) After Tax Cut/16 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.093
(p-value: 0.0012)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

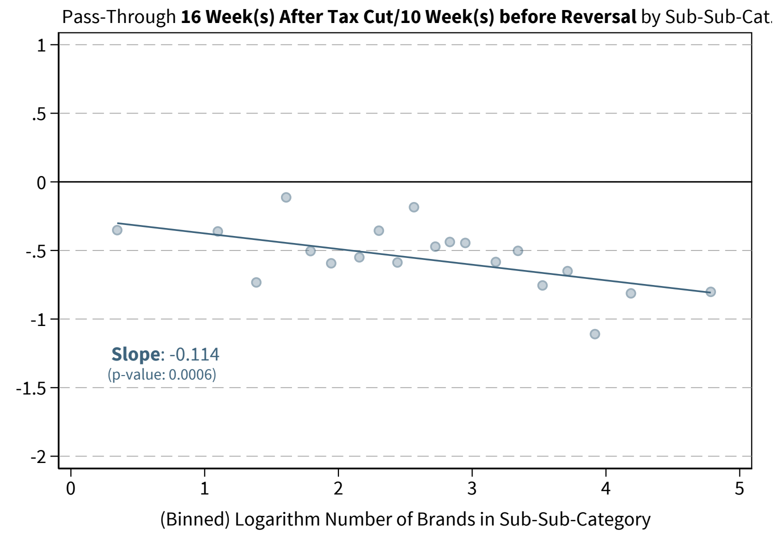

Pass-Through **11 Week(s) After Tax Cut/15 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.071
(p-value: 0.0327)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

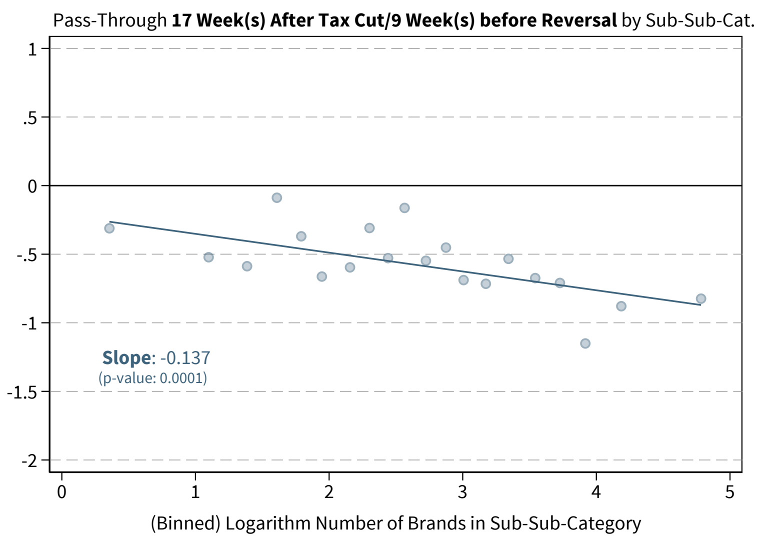

Pass-Through **12 Week(s) After Tax Cut/14 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.113
(p-value: 0.0000)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

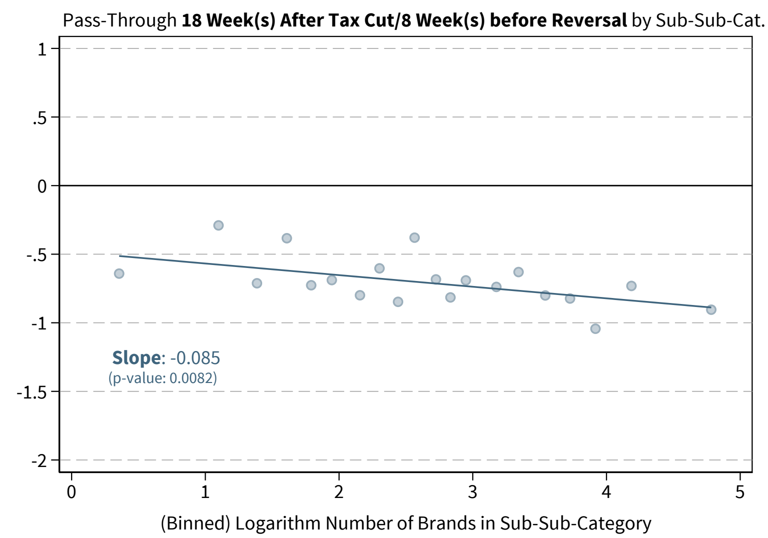

Pass-Through **13 Week(s) After Tax Cut/13 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.089
(p-value: 0.0011)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

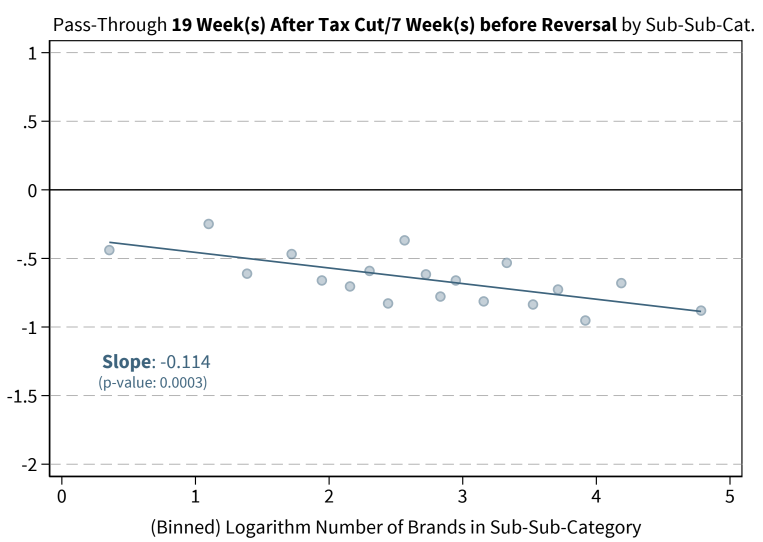

Pass-Through **14 Week(s) After Tax Cut/12 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.117
(p-value: 0.0000)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

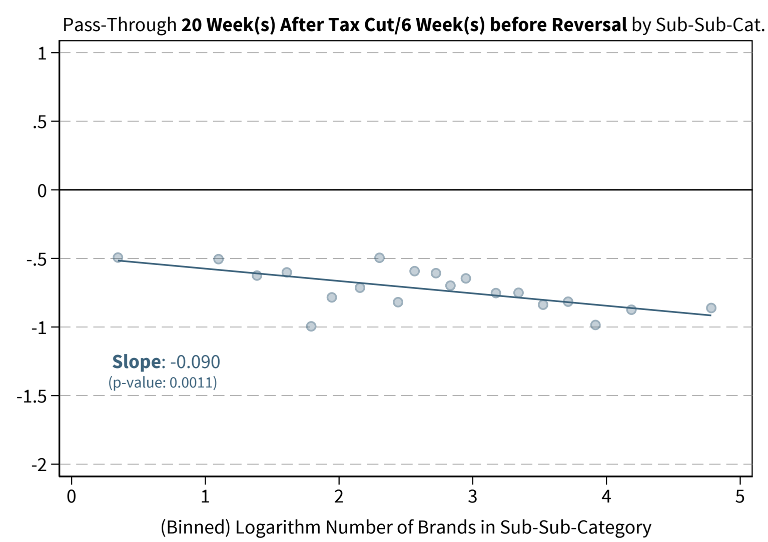

Pass-Through **15 Week(s) After Tax Cut/11 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.086
(p-value: 0.0009)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

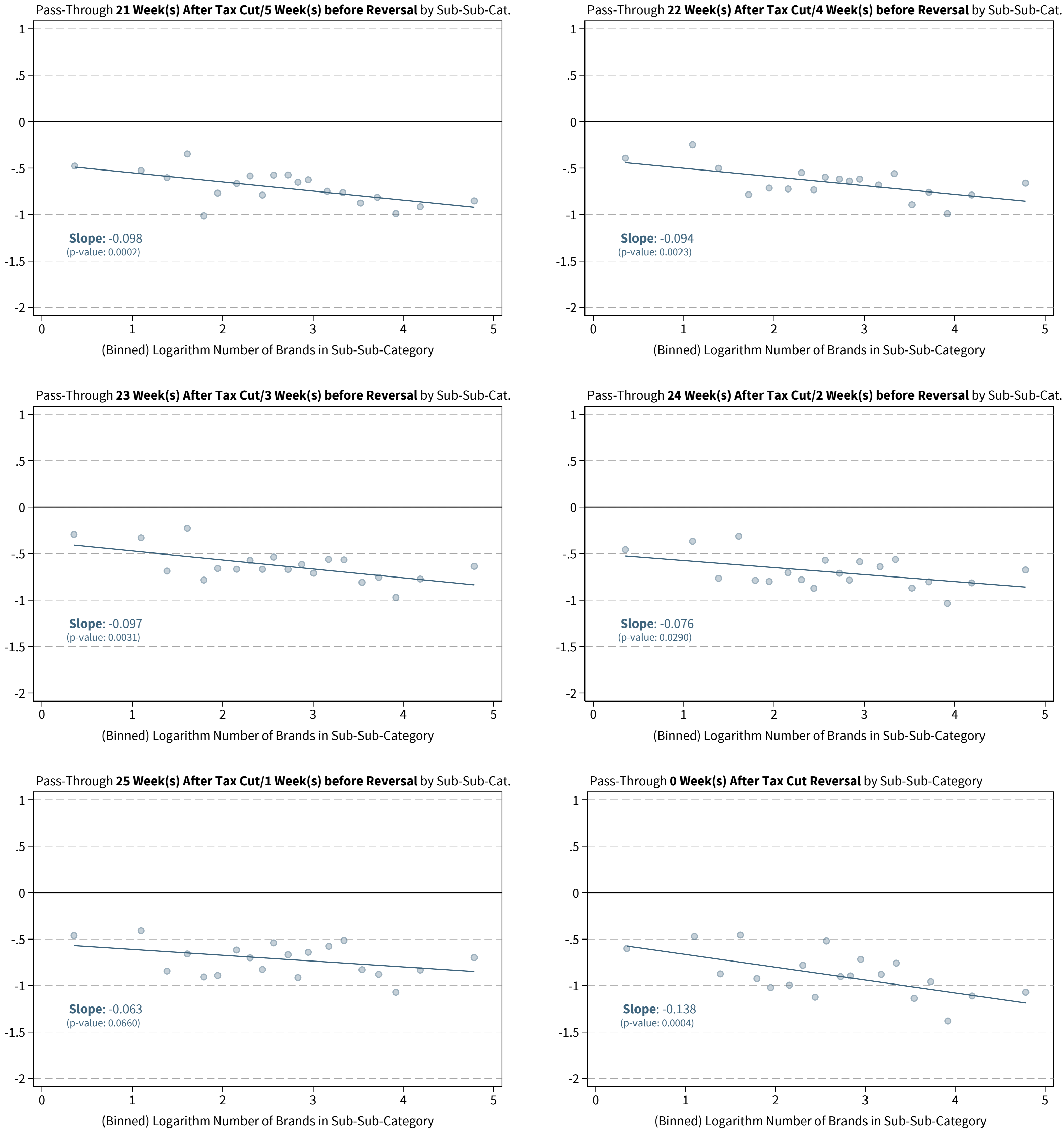

Pass-Through **16 Week(s) After Tax Cut/10 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.114
(p-value: 0.0006)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

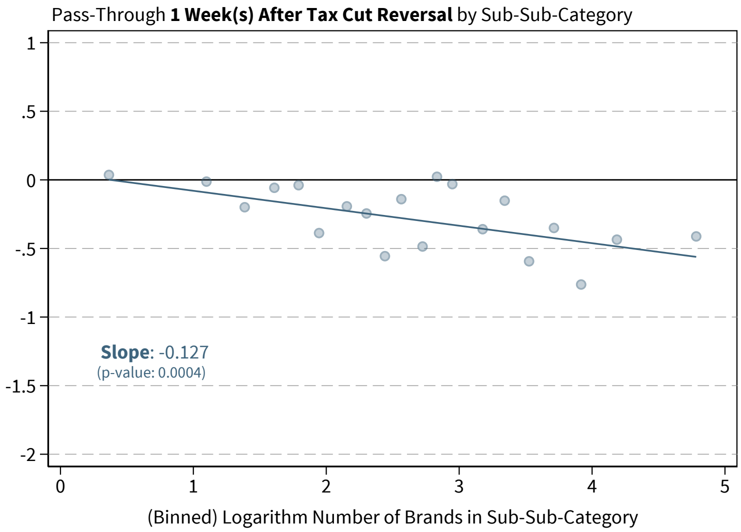

Pass-Through **17 Week(s) After Tax Cut/9 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.137
(p-value: 0.0001)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

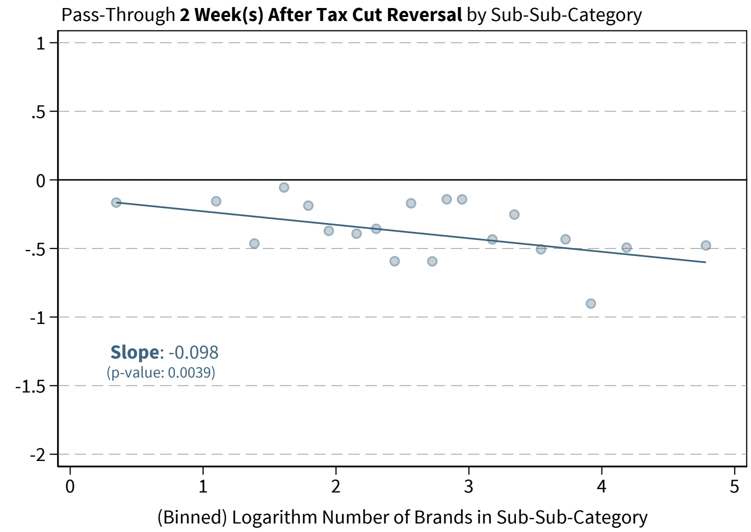

Pass-Through **18 Week(s) After Tax Cut/8 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.085
(p-value: 0.0082)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

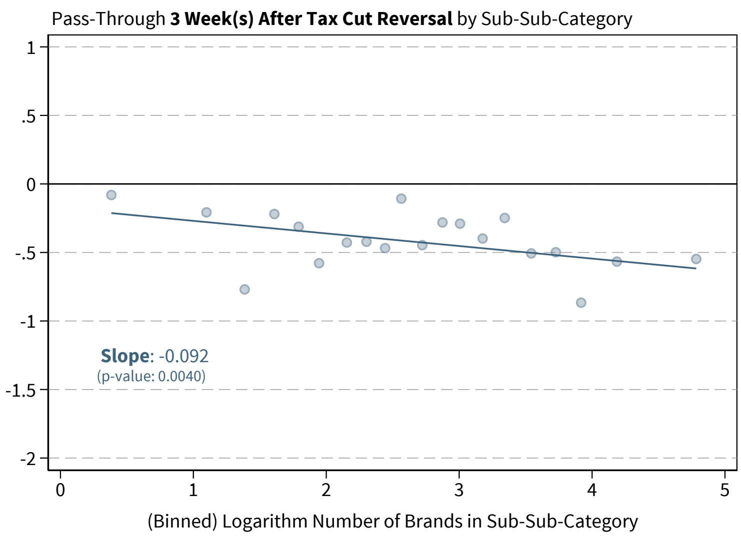

Pass-Through **19 Week(s) After Tax Cut/7 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.114
(p-value: 0.0003)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

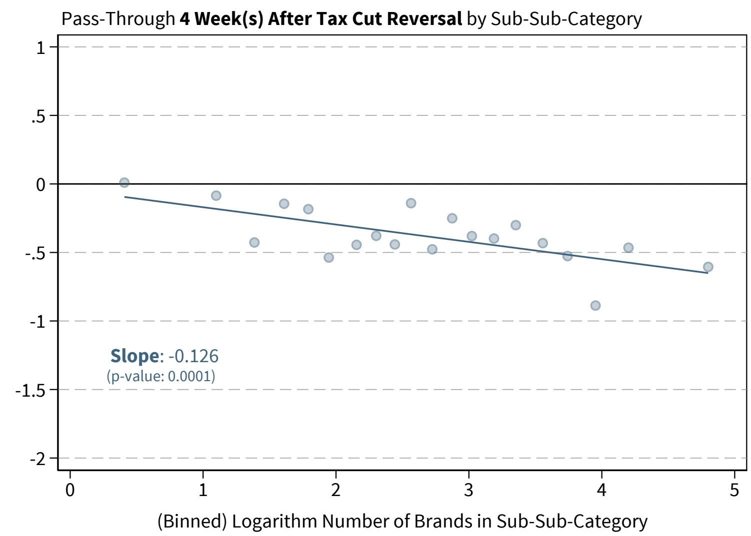

Pass-Through **20 Week(s) After Tax Cut/6 Week(s) before Reversal** by Sub-Sub-Cat.
1
.5
0
-.5
-1
-1.5
-2
Slope: -0.090
(p-value: 0.0011)
0
1
2
3
4
5
(Binned) Logarithm Number of Brands in Sub-Sub-Category

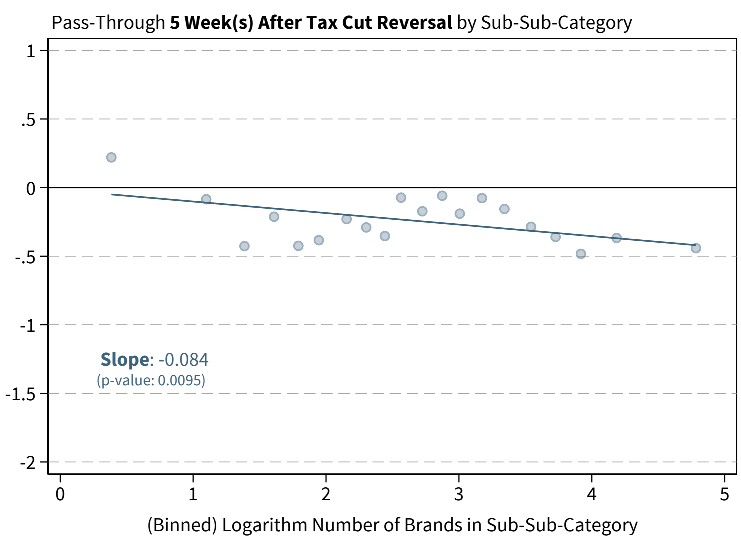

Pass-Through **21 Week(s) After Tax Cut/5 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.098
(p-value: 0.0002)
(Binned) Logarithm Number of Brands in Sub-Sub-Category
Pass-Through **22 Week(s) After Tax Cut/4 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.094
(p-value: 0.0023)
(Binned) Logarithm Number of Brands in Sub-Sub-Category
Pass-Through **23 Week(s) After Tax Cut/3 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.097
(p-value: 0.0031)
(Binned) Logarithm Number of Brands in Sub-Sub-Category
Pass-Through **24 Week(s) After Tax Cut/2 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.076
(p-value: 0.0290)
(Binned) Logarithm Number of Brands in Sub-Sub-Category
Pass-Through **25 Week(s) After Tax Cut/1 Week(s) before Reversal** by Sub-Sub-Cat.
Slope: -0.063
(p-value: 0.0660)
(Binned) Logarithm Number of Brands in Sub-Sub-Category
Pass-Through **0 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
Slope: -0.138
(p-value: 0.0004)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

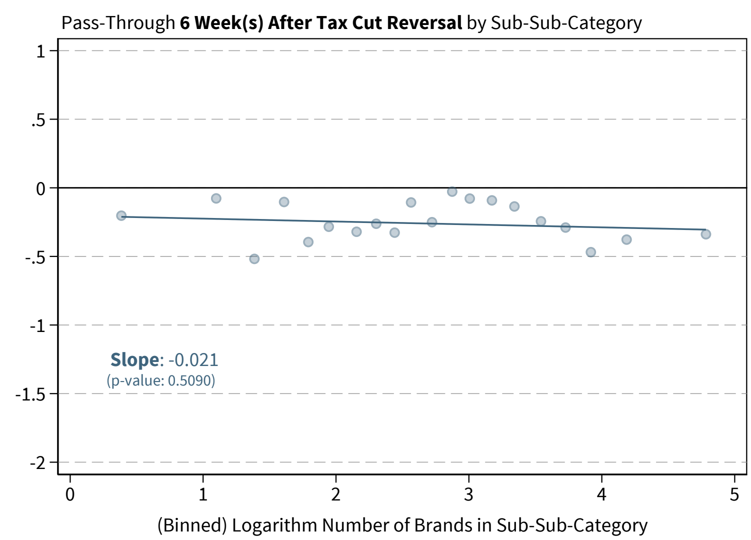

Pass-Through **1 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.127
(p-value: 0.0004)
(Binned) Logarithm Number of Brands in Sub-Sub-Category


Pass-Through **2 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.098
(p-value: 0.0039)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

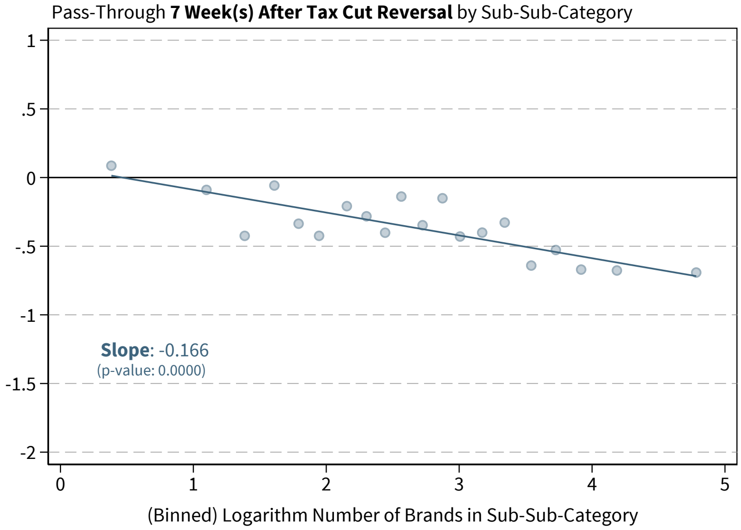

Pass-Through **3 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.092
(p-value: 0.0040)
(Binned) Logarithm Number of Brands in Sub-Sub-Category


Pass-Through **4 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.126
(p-value: 0.0001)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

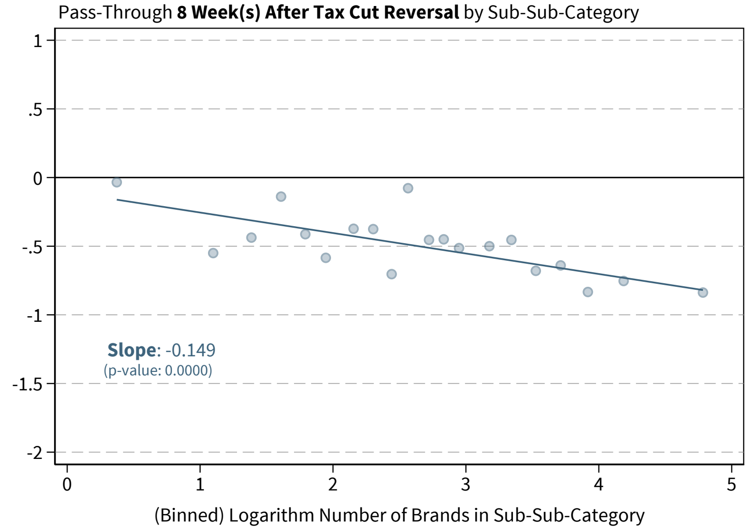

Pass-Through **5 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.084
(p-value: 0.0095)
(Binned) Logarithm Number of Brands in Sub-Sub-Category


Pass-Through **6 Week(s) After Tax Cut Reversal** by Sub-Sub-Category
1
.5
0
-.5
-1
-1.5
-2
0
1
2
3
4
5
Slope: -0.021
(p-value: 0.5090)
(Binned) Logarithm Number of Brands in Sub-Sub-Category

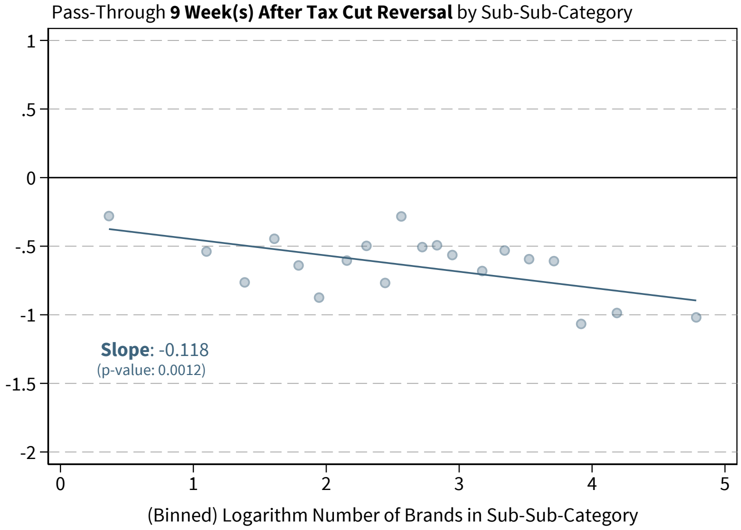
Pass-Through **7 Week(s) After Tax Cut Reversal** by Sub-Sub-Category



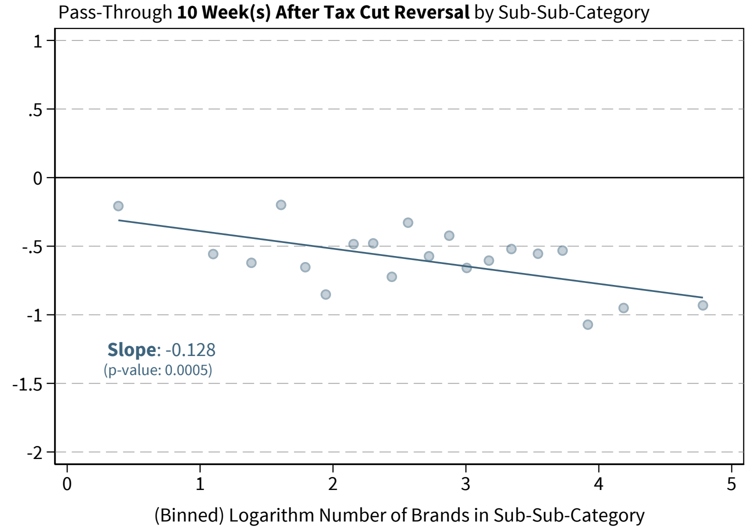
Pass-Through **8 Week(s) After Tax Cut Reversal** by Sub-Sub-Category



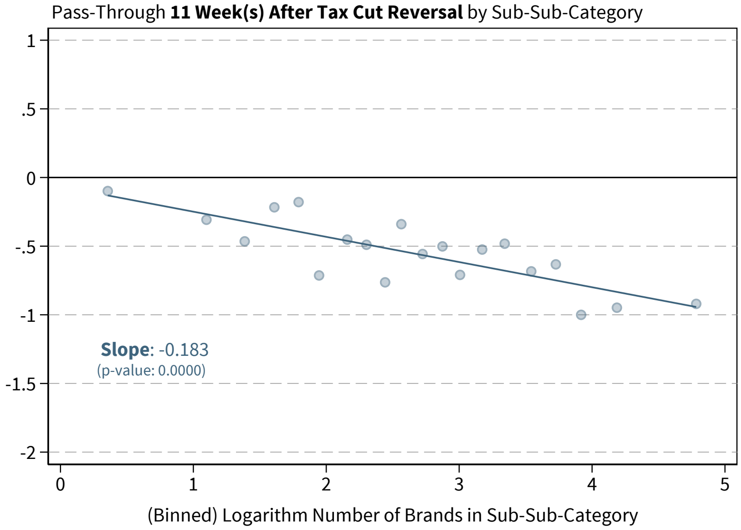
Pass-Through **9 Week(s) After Tax Cut Reversal** by Sub-Sub-Category



Pass-Through **10 Week(s) After Tax Cut Reversal** by Sub-Sub-Category



Pass-Through **11 Week(s) After Tax Cut Reversal** by Sub-Sub-Category



Appendix C. Derivation of Comparative Statics

In this appendix, we derive the comparative static effect of changes in the substitutability parameter σ_i on p_i and n_i. Totally differentiating Equation (4) and (5) and solving for dp_i and dn_i yields

$$\frac{dp_i}{d\sigma_i} = \frac{(1-t^L)(1-\frac{1}{\sigma_i^2})}{(1-t^L)(1-\frac{1}{\sigma_i}) + c''\left(\frac{e_i}{p_i^2 n_i}\right) + c''\left(\frac{e_i}{p_i^2 n_i^2 F_0}\right)c'} < 0, \tag{8}$$

and

$$\frac{dn_i}{d\sigma_i} = -\frac{(1-t^L)\frac{1}{\sigma_i^2}\frac{e_i}{p_i^2 F_0}c'}{(1-t^L)(1-\frac{1}{\sigma_i}) + c''\left(\frac{e_i}{p_i^2 n_i}\right) + c''\left(\frac{e_i}{p_i^2 n_i^2 F_0}\right)c'} < 0. \tag{9}$$