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Taxes and Gender Equality: The Incidence of the 'Tampon Tax'

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Abstract

Many countries are currently debating whether to reduce or eliminate taxes on feminine hygiene products as a measure to address “period poverty” and promote gender equality. Legislators often reject proposals involving reforms of “tampon taxes” as the pass-through of sales taxes into consumer prices cannot be guaranteed. This paper uses a permanent reduction of the tax on tampons & pads in Germany in 2020 as a natural experiment to study the price and unit-sales effects of the tax. Exploiting an extensive data set on the unit sales and scanner prices of feminine hygiene products in Germany and Italy, our results indicate that the incidence of tampon taxes is fully on consumers, while demand for these products is price-inelastic. We do not find cross-price effects for a closely related product group, which remained taxed at the standard tax rate. Both the pass-through and demand effects are found to be homogenous along the pre-reform market-share and price distributions.

JEL-Codes: H220, H230, I380, J160.

Keywords: tax incidence, pass-through, gender equality, feminine hygiene products, period poverty.

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1 Introduction

As affordable access to sanitation is a basic human right, proponents of abolishing the “tampon tax”, i.e. sales tax or VAT on female menstrual products, argue that in the context of these products “[...] the sales tax emerges as a key obstacle to gender equality and human rights” (Crawford and Spivack, 2017). Period poverty, defined as a limited to no access to essential menstrual products, broadly encompassing inadequate or absent infrastructure and resources for hygiene management, is considered to be an important factor behind female work and school absenteeism, poor health and other detrimental outcomes (e.g., Hunter et al., 2022, Medina-Perucha et al., 2023, P. Das et al., 2015). Restrictions on women’s and girls’ socio-economic participation stemming from unmet menstrual needs can hinder their ability to work and study, thus further exacerbating gender inequality. Consumption taxes such as retail sales taxes and value-added taxes (VAT) have therefore taken a centre stage in tackling period poverty as they directly address these products’ affordability and accessibility.

Recently, a growing number of countries have been reclassifying feminine hygiene products to reduced tax rates or have exempted them from taxation altogether. About 15 US states have already repealed sales taxes on sanitary products, while others have introduced bills to do so. In Europe, over half of the European Union (EU) member states have reclassified menstrual hygiene products for VAT purposes and currently tax them at reduced or super-reduced rates. These reclassifications are, however, often met with considerable opposition and implemented after long delays. Policy makers use two main arguments against cutting VAT on feminine hygiene articles: First, it is unclear whether the targeted products would become more affordable as a VAT-reduction’s pass-through into consumer prices cannot be guaranteed. In line with this reasoning, the German and Croatian governments, amongst others, initially rejected petitions/proposals to lower the “tampon tax”.¹

¹The official position of the German federal government regarding its rejection of a 2016 petition to lower VAT on menstrual products states: “[...]The petitioner evidently assumes that a reduction in the tax rate for the aforementioned products would lead to correspondingly falling prices. In this regard, the Committee on Petitions points out that the sales tax only represents one component of the costs incurred in the retail sector. The passing on of a sales tax saving to customers would be at the sole discretion of the entrepreneur, is dependent on the competitive position and could not be ensured by the legislator. In this respect, the Committee expresses the position that the reduction of the sales tax on the above-mentioned products, as demanded by the petition, could not be a suitable means to achieve the goal sought by the

In fact, recent economic literature highlights an asymmetry in the incidence of VAT, where tax decreases are found less likely to be completely shifted into prices (e.g., [Benzarti, Carloni, et al., 2020](#), [Benedek et al., 2020](#)). Second, revenue losses are frequently brought at the forefront of the debate as was the case for example in France and Italy.² Also in the US, anti-tampon-tax bills often fail to gain traction due to concerns over fiscal costs.³

A standard motivation behind cutting taxes on specific commodities or reclassifying these commodities to categories subject to reduced tax rates is to support employment and investment in specific industries and can ensue from (sector-specific) lobbying efforts (e.g., sit-down restaurants in France, accommodation services in the Czech Republic and Slovakia). Lower taxes are also advanced to meet environmental objectives (e.g., long-distance travel in Germany), to improve tax compliance in labor-intensive services (e.g., hairdressing in Finland), or as an instrument of redistributive policy. The latter use has been criticized as inefficient by [Auerbach \(2010\)](#) who highlights commodity taxes' inability to precisely target specific population groups.⁴

Proposals to lower the “tampon tax” differ, as feminine hygiene products are used by a well-defined population group. Regarding the objection that the measure cannot be differentiated by income, advocates emphasize that period poverty may be an issue particularly for groups that are difficult to

petitioner in the long term.[...]” Pet 2-18-08-6120-021287 “Umsatzsteuer.” Retrieved from https://epetitionen.bundestag.de/petitionen/_2015/_04/_16/Petition_58474.abschlussbegrueundungpdf.pdf. Similar arguments were raised in Croatia, where a proposed amendment of the VAT Act was voted down twice before being adopted in 2022. Specifically, the director of the Croatian Tax Administration argued that lowering the VAT on food, medicines, energy and municipal services did not result in lower prices, implying that a similar outcome should be anticipated for menstrual products. “Croatia Again Rejects Lower VAT on Period Products” *BalkanInsight*. Retrieved from <https://balkaninsight.com/2021/10/22/croatia-again-rejects-lower-vat-on-period-products/>

²France and Italy initially rejected VAT cuts for feminine hygiene products due to high expected VAT revenue losses (55 mil. Euro in France and above 200 mil., Euro in Italy), but reversed their positions at a later stage. “France rejects ‘tampon tax’ change” (BBC, 15.10.2015). Retrieved from <https://www.bbc.com/news/world-europe-34538672>; “‘Think ahead’: Italy MPs get incontinence warning after rejecting move to lower tampon tax” (Euronews, 16.05.2019). Retrieved from <https://www.euronews.com/2019/05/15/think-ahead-italy-mps-get-incontinence-warning-after-rejecting-move-to-lower-tampon-tax>.

³“22 States Considered Eliminating the ‘Tampon Tax’ This Year. Here’s What Happened.” (The New York Times, 12.07.2019). Retrieved from <https://www.nytimes.com/2019/07/12/us/tampon-tax.html>

⁴Empirical studies support this concern (e.g., [Liberati, 2001](#), [Boeters et al., 2010](#)). Reduced rates on food, transport services and health products amongst others aimed at mitigating the regressivity of consumption taxes are therefore often criticized for contributing to a “tax base erosion” ([Borselli, Chiri, and Romagnano, 2012](#)).

reach through conventional redistributive means.⁵ Further, sanitary articles for women in the US, for instance, are currently not eligible for coverage under food stamps or Supplemental Nutrition Assistance programs.⁶

Moreover, feminine hygiene products constitute basic necessities that are essential to women's everyday social and economic interactions. As necessities, economic theory suggests that their demand may be rather inelastic and hence, that a tax cut is likely to be fully shifted into prices. In that case, contrary to governments' expectations, lowering the sales tax or VAT may be an effective way of enhancing gender equality by mitigating the degree to which women are disadvantaged on the basis of their biology. This conjecture is supported by [Cotropia and Rozema \(2018\)](#) who study the repeal of the tampon sales tax in New Jersey in 2005 and show that relative to other states, New Jersey's prices fully reflect the exclusion of menstrual hygiene products from the state's tax base. To the best of our knowledge, no other rigorous evidence exists on the matter.

This paper uses the German VAT reclassification of feminine hygiene products, which lowered the VAT rate on pads and tampons from 19 to 7% on January 1st, 2020 as a natural experiment to study the incidence of VAT in a setting with exogenous variation in tax rates. The reform was implemented in response to a successful activists-initiated petition in 2019 and was unrelated to prevailing economic conditions in Germany at the time. A specific feature of the German reform is that panty liners remained fully taxed as they are not exclusively used for menstrual hygiene. This enables us to test for cross-price and sales effects of the VAT reform on these non-treated substitutes. Using weekly product-level data on the unit sales and scanner prices for the entire bricks-and-mortar market for sanitary products in Germany and Italy, we implement two types of difference-in-differences specifications as well as a triple difference design to elicit the average price and demand responses to the reduction of the tax rate. Counterfactuals are constructed either from the contemporaneous sales and prices of Italian tampons & pads, from standard-rated liners in

⁵For example, welfare programs targeting households may fail to benefit women due to discrimination within the household. Additionally, illegal immigrants, women employed in the informal sector and other vulnerable populations are perhaps not reachable through more targeted cash transfers or deductions through the income tax.

⁶See for example the discussion in "Changing the Cycle: Period Poverty as a Public Health Crisis", <https://sph.umich.edu/pursuit/2020posts/period-poverty.html>.

Germany, or a combination of the three product groups with data for both countries. We supplement the analysis with event-study specifications, which not only allow us to follow dynamic adjustments over time and to check for any reversals in the pricing of menstrual products in the longer-run, but also to formally assess some of the identifying assumptions in the estimation.

Our results indicate that the reduced tax rate is fully passed on to the consumer and that consumers do not change their behavior. Moreover, no cross-price effects are exerted on other feminine hygiene products, which are still taxed at the regular VAT rate. These findings reflect a perfectly inelastic demand that dominates the market response. At least a year and a half post-reform, we do not find evidence of a price creep indicating that the price reduction persists. Price pass-through and sales responses appear to be homogenous across products in different market-share quartiles, or pre-event price quartiles. The annual cost of the policy is estimated to be about 0.02% of total VAT revenue.

Our findings have implications for recent proposals to lower the “tampon tax”. As our results indicate that the tax is fully passed on to consumers, reducing sales taxes or VAT on feminine hygiene products can be an effective tool for improving their affordability and thus a step towards tackling period poverty. Putting such reforms on hold due to unclear pass-through risks foregoing economic gains from advancing gender equality. Furthermore, the lack of behavioral responses implies likely limited revenue losses that can be relatively precisely budgeted for in advance.⁷

Our paper is related to the empirical literature on the incidence of VAT and sales taxes. The bulk of the extant evidence comes from case studies that often find that instead of being fully reflected into prices, tax cuts could end up increasing corporate profits (e.g., Harju and Kosonen, 2014, Kosonen, 2015, Benzarti and Carloni, 2019, Benzarti, Carloni, et al., 2020, Brokelind and Thiel, 2020). A more comprehensive analysis by Benedek et al. (2020), who allow for differential price effects

⁷The question of whether lowering the consumption tax on feminine hygiene and absorbent hygiene products enhances their affordability is even more pressing politically, as from 2022 the European VAT Directive allows for their zero-rating. No country has yet taken advantage of this option. ‘Tracking tampon tax: No EU27 nations leverage new feminine hygiene full VAT exemption’. Retrieved from <https://www.personalcareinsights.com/news/tracking-tampon-tax-no-eu27-nations-have-leveraged-new-feminine-hygiene-full-vat-exemption.html>.

by type of VAT change, estimates limited pass-through of only 13-16% for 23 reclassifications of commodities in 10 EU countries. As these papers often focus on the price responses of goods and services that are not (biological) necessities, their findings may be uninformative for the incidence of tampon taxes.⁸ In fact, in the context of food products, [Gaarder \(2019\)](#) shows that a large VAT reduction in Norway was completely shifted to consumer prices. Also for tobacco consumption, where a large literature points to a relative insensitivity of adult smoking to prices ([DeCicca, Kenkel, and Lovenheim, 2022](#)), findings indicate strong pass-through of local cigarette taxes, which differs by consumer type and weakens near state-borders (e.g., [DeCicca, Kenkel, and Liu, 2013](#)).⁹

Furthermore, in many instances the pass-through estimates are based on the COICOP harmonized consumer price index and analysis of quantity responses is missing, mostly due to data limitations. Using scanner prices, [Buettner and Madzharova \(2021\)](#) find a complete pass-through of standard VAT changes into prices for a large number of EU reforms, but demonstrate that their pass-through estimates are underestimated by close to 60% if they relied on COICOP price data instead. There is some unclarity therefore, whether incomplete pass-through findings of VAT cuts are a data-driven or indeed a policy-specific outcome.

The paper proceeds as follows. The next section discusses general trends in sales taxation/VAT of feminine hygiene products and the specific institutional context of the German reform. Section 3 describes the data. The methodology is laid out in Section 4, while the main results are given in Section 5. Section 6 provides a brief summary and concludes.

⁸The consumption categories subject to reclassification covered in [Benedek et al. \(2020\)](#), which overlap with those in specific case studies, are: mineral waters, soft drinks, fruit & vegetable juices; tobacco; cleaning, repair, & hire of clothing; services for the maintenance and repair of the dwelling; other services related to the dwelling; gas; domestic and household services; pharmaceutical products; gardens, plants and flowers; restaurants, cafes and the like; canteens; accommodation services; hairdressing saloons and personal grooming establishments.

⁹In addition to the role of the price elasticity of demand for price pass-through, the literature also emphasizes the role of tax evasion (e.g., [Kopczuk et al., 2016](#), [Bibler, Teltser, and Tremblay, 2021](#)). However, given the nature of the goods under consideration in this paper, tax evasion is likely to have a limited effect. Furthermore, unlike sales taxes, value-added taxes are imposed along the entire value chain, which mitigates evasion responses.

2 Lowering Taxes on Feminine Hygiene Products: Institutional Context

In Germany, the VAT rate on feminine hygiene products was permanently lowered from 19% to 7% effective from January 1st, 2020. The German reform follows a wave of similar legislation worldwide. Many countries, including Kenya, Canada and more than half of the U.S. states have already removed these products from the tax base of the consumption tax while many others are considering similar measures. The argumentation is largely overlapping across jurisdictions – the tax is seen as a form of gender discrimination (e.g. [Crawford and Waldman, 2018](#); [Cotropia and Rozema, 2018](#)). The narrative invariably relies on a “relative fairness” reasoning that compares the merits of other presently exempt/reduced-rated goods¹⁰ to the full-tax status of feminine hygiene essentials.

Since 2007, the European VAT Directive includes products for sanitary protection on the list of goods and services to which member states can choose to apply a reduced VAT rate.¹¹ The amendment of the Directive in 2022¹² further allows for their zero-rating. Table 1 reports the year of reclassification (if any) in the EU countries and in the UK as well as the current tax status of feminine hygiene articles. Their average tax rate in reclassifying countries amounts to 6.6% compared to 22.4% in the remaining predominantly east European and Scandinavian economies. Currently, only Ireland and the UK zero-rate this product category.

The German policy change was prompted by a grassroots petition initiated in 2019, which gathered the necessary support and was eventually debated and later accepted by the German federal parliament. An earlier petition in 2016 was rejected by the Federal government on the grounds that the pass-through depends on the market and cannot be ensured by the legislator. In response to the second petition, sanitary products such as pads and tampons were re-classified for VAT purposes as everyday necessities that can be subject to a reduced rate. Nevertheless, because of its narrow

¹⁰For example, salmon caviar or products addressing elective medical concerns of men, which do not hinder their social participation.

¹¹Annex III, Council Directive 2006/12/EC of 28 November 2006 on the common system of value-added taxes.

¹²Council Directive (EU) 2022/542 of 5 April 2022 amending Directives 2006/112/EC and (EU) 2020/285 as regards rates of value added tax

Table 1: Taxation of feminine hygiene products in the EU

Country	Reclassification	Reduced rate	Standard rate
Austria	Jan.2021	10	
Belgium	Aug 2018	6	
Bulgaria	–		20
Croatia	April 2022	13	
Cyprus	Oct. 2007	5	
Czech Republic	–		21
Denmark	–		25
Estonia	n.a.	9	
Finland	–		
France	Jan. 2016	5.5	
Germany	Jan. 2020	7	
Greece	2018	13	
Hungary	–		27
Ireland	Before EU mem.	0	
Italy	Jan. 2022	4	
Latvia	–		21
Lithuania	–		21
Luxembourg	May 2019	3	
Malta			
Netherlands		9	
Poland	2018	5	
Portugal	June 2022	6	
Romania	–		19
Slovakia		10	
Slovenia	May 2021	9.5	
Spain	n.a.	4	
Sweden	–		25
United Kingdom	2000	0	

Notes: The table reports the timing of the VAT reclassification (if any) of feminine hygiene products in the countries of the EU and in the UK as well as the currently applying tax rate on these products as of 2023. Several countries, such as Spain, the UK, and Poland (e.g., Poland cut the reduced VAT rate from 8 to 5 in 2020) have lowered the VAT rate on sanitary products again post-reclassification. Any intermediate tax rates, which no longer apply, are not listed.

interpretation of the VAT Directive, the German VAT law still provides for panty liners to be taxed at the standard rate as this type of product is not exclusively used for menstrual hygiene.

Given its motivation, timing, and its focus on promoting gender equality through taxes, the permanent tax cut on women's sanitary products, effective January 1, 2020, was clearly exogenous to economic conditions in Germany. Later in the year, however, the outbreak of the Covid-19 pandemic resulted in a lock-down in Germany on March 16th, 2020, with essential retailers such as supermarkets, drug stores and pharmacies being allowed to remain open. To counteract the effects of the pandemic, the German government implemented stimulus measures, including a temporary reduction of the standard VAT rate from 19% to 16% and of the reduced rate from 7% to 5% announced in June 2020 and effective from July 1st, 2020. The announcement indicated that rates will revert back to their original levels on January 1st, 2021. Another, less restrictive lock-down occurred in November 2020. Both lock-downs and temporary changes of VAT rates are likely to have affected the purchases of feminine hygiene products, which belong to the set of consumer goods that are non-durable but storable. Hence, intertemporal shifting of purchase decisions could have emerged around these shocks if consumers anticipated lower future prices or shortages. At the time the tax rate was changed, this pandemic development was not foreseeable. We therefore use in particular the period leading up to the outbreak of the pandemic to analyze the effects of the reclassification, which resulted in a permanent tax reduction on feminine hygiene products. We also examine further market developments beyond the lock-down and the stimulus measures.

3 Data

We use product-level weekly panel database from the marketing analytics company Information Resources (IRi) GmbH consisting of three types of feminine hygiene products: (i) pads, (ii) tampons and (iii) panty liners. The data spans 157 weeks from week 27 (W27) starting on July 2nd, 2018 to W27 ending on July 11th, 2021 for two countries – Germany and Italy.¹³ In the time period under consideration, Germany lowered the tax rate on pads and tampons, while Italian tax law on

¹³The Italian data coverage is one week shorter to W26 ending on July 4th, 2021.

disposable sanitary products remained unchanged.¹⁴

For each product, the data contains the scanner price, units sold (number of packs), volume sold (number of packs times number of pads/tampons/liners within a pack), brand, corporation, and several product-specific characteristics summarized by type in Table A-1 in the Appendix. Scanner prices are inclusive of VAT. Given the limited salience of the US retail sales taxes (e.g., Chetty, Looney, and Kroft, 2009), it should be noted that in Germany and Italy consumer prices are regularly displayed inclusive of VAT. Hence, the consumer is aware of the gross price inclusive of the tax burden in accordance with the above Ramsey exclusion restriction. Moreover, the scanner prices reflect any promotional activities taking place throughout the duration of the panel.¹⁵ Products are uniquely identified by an (anonymized) Universal Product Code (UPC), which differs by country even if it pertains to the same product. A total of 1,111 products are observed in Germany, and 1,288 products in Italy. The national brands are also anonymized, but consistently across countries, such that a brand b sold in Germany is equivalent to brand b in Italy. In both countries, retailer brands (a.k.a., store brands¹⁶) are not differentiated and bear a common label of “retailer brand.” While products classified under retailer brands appear in the German data at the product-level, in Italy the data for these products is aggregated by type for each week. The database covers the entire brick-and-mortar market for the three types of sanitary products in Germany, and the Italian market for national brands.¹⁷

Table 2 reports descriptive statistics for the pre-treatment period 2018-2019 differentiating between pads & tampons and liners for the entire German market in panel A, the German market covering only national brands in panel B, and the Italian market consisting of national brands in C. Retailer

¹⁴Italy did reduce VAT on *compostable and washable* sanitary pads and reusable menstrual cups contemporaneously with Germany in 2020, but these products, whose market share is estimated at 0.4% are not part of the data for either country. Regular disposable sanitary products in Italy were also re-classified to lower tax rates, but only in 2022, two years after the German reform, which is outside of the time-period under investigation and hence, does not affect the estimation of the counterfactuals.

¹⁵IRi considers a price reduction greater or equal to 5% for a maximum duration of six weeks to be a price promotion. Any price reduction extending beyond this period is regarded as the new price of a product.

¹⁶For example, brands such as DM and Rewe as opposed to national brands like Always, Libresse, OB, etc.

¹⁷The relevant retailers in the data production are discounters, drugstores, and food retailers with floor space of 200 m² or more in Germany, and super-, hyper-stores, discounters, drugstores, and small self-service stores in Italy. The data does not distinguish sales by retailer and does not include online retailers.

Table 2: Descriptive Statistics by Product Type and Country prior to German VAT Reduction

	Mean	Std. Dev.	Min	Max	N
A. Germany					
Pads & Tampons					
Price	2.147	1.342	0.217	8.99	30,201
Price per item	0.102	0.118	0.005	1.392	30,201
Units (Packs)	8,546	16,315	1	177,700	30,201
Volume	203,750	460,404	2	6,186,364	30,201
Items per pack	29.09	20.69	2	80	30,201
Liners					
Price	1.799	0.880	0.010	5.175	19,727
Price per item	0.042	0.028	0.0003	0.250	19,727
Units (Packs)	9,844	17,477	1	151,209	19,727
Volume	449,176	836,530	5	7,790,831	19,727
Items per pack	48.30	24.40	5	280	19,727
B. Germany, excluding retailer brands					
Pads & Tampons					
Price	3.036	1.402	0.500	8.99	12,710
Price per item	0.157	0.156	0.021	1.392	12,710
Units (Packs)	9,378	20,140	1	177,700	12,710
Volume	241,454	627,660	9	6,186,364	12,710
Items per pack	26.53	18.55	3	72	12,710
Liners					
Price	2.389	0.798	0.010	5.175	10,684
Price per item	0.049	0.021	0.0003	0.200	10,684
Units (Packs)	9,806	20,075	1	151,209	10,684
Volume	494,914	1,004,740	20	7,790,831	10,684
Items per pack	55.23	29.64	18	280	10,684
C. Italy (no retailer brands)					
Pads & Tampons					
Price	3.011	2.462	0.120	19.8	45,240
Price per item	0.178	0.115	0.009	1.275	45,240
Units (Packs)	4,059	12,574	0.605	217,508	45,240
Volume	58,715	166,473	8	2,271,103	45,240
Items per pack	18.10	14.18	7	112	45,240
Liners					
Price	2.792	1.927	0.240	16.99	20,354
Price per item	0.075	0.044	0.006	0.429	20,354
Units (Packs)	2,832	8,207	0.94	103,453	20,354
Volume	103,346	319,044	15.594	4,551,937	20,354
Items per pack	44.87	41.62	10	240	20,354

Notes: The table shows summary statistics per product per week per product-category averaged over time and product. All reported prices are in Euro. The statistics refer to the period 2018-2019, i.e. before Germany's reclassification of tampons & pads to the group of products taxed at a lower rate entered into force. Volume is unit packs times the number of individual pads/tampons/liners within a pack (items per pack). Prices are inclusive of VAT. Panel A summarizes the entire German market, while Panel B excludes retailer brands. Panel C summarizes the Italian market, excluding retailer brands, which are not available at the product level. For summary statistics of the full sample (2018-2021), refer to Table A-2 in the Appendix.

brands are central to the German market commanding a market share of 50%, and play less significant role in Italy, where their share in total unit-sales ranges between 21-24%. In the period under consideration, 67 different national brands are represented in Italy compared to 14 in Germany. On average, 8.5(9.8) thousand packs of tampons/pads (liners) are sold per week per product in Germany at the average price of 10 cents (4.5 cents) per item. There are substantial differences in pricing with retailer brands serving predominantly the lower segments of the market as shown in Figure A-1 in the Appendix, which overlays price distributions by type of brand by group.¹⁸

Italian weekly sales per product are less than half of those in Germany, and for liners – less than one-third. Comparing panels B and C reveals that, on average, pads & tampons (liners) in Italy are 2.1 (2.6) cents more expensive per item than in Germany. Even though the average products purchased in Germany and Italy differ in terms of brand and product characteristics, the higher consumer price in Italy is in accordance with its 3 pp higher VAT rate.

4 Methodology

As explained in Section 3, all products in the data belong to a set of three product groups denoted by $g = \{[i], [ii], [iii]\}$, where group $[i]$ is pads, $[ii]$ is tampons, and $[iii]$ is liners, and a set of two countries $c = \{DE, IT\}$, namely Germany and Italy. Henceforth, we use the terms “group”, “category”, and “type” interchangeably.

To assess the extent and speed of the pass-through of the VAT cut into consumer prices and estimate any possible quantity effects, we consider both static and dynamic difference-in-differences specifications. The average long-run effect on prices/unit sales is estimated based on the following equation:

$$\ln Y_{i,g,c,t} = \alpha_i + \beta \text{Treat}_{c,t} + \gamma_t + \lambda_{g,t} + \epsilon_{i,g,c,t}, \forall i \in g \setminus \{[iii]\}, i \in c \quad (1)$$

¹⁸Based on the aggregated data for store brands, price differentials of similar magnitude are also observed in Italy.

Eq. (1) compares price/quantity changes in tampons and pads in Germany to the contemporaneous developments in these outcomes for the same product categories in Italy. Liners, which remain subject to the standard VAT rate in Germany, are excluded from the estimation. The dependent variable is either the log of the price or the log of the unit sales of product i in group g sold in country c at time t , which varies by week and by year. α_i and γ_t are product-specific and week-by-year fixed effects, respectively. The former capture all time-invariant unobserved product characteristics as well as nest group and country fixed effects as the product identifiers are unique across countries, while the latter control for aggregate shocks affecting prices and sales in either country. The time- and country-specific treatment indicator, $\text{Treat}_{c,t} := 1\{t \geq W1, 2020 \cup c = \{DE\}\}$, equals one for all German products from the first week (W1) in January 2020 onward. The β coefficient measures the average treatment effect, identified from the differences in the tax treatment of the same product types between countries. More specifically, the identification of eq. (1) rests first on the assumption that before the German reform the sales/prices of Italian pads and tampons move in parallel to those of the same product groups in Germany, and second, that the tax reduction in Germany does not affect the outcomes for pads and tampons in Italy (no-interference or stable-unit treatment-value assumption (SUTVA)). As the VAT rate change amounts to -12 percentage points (pp), with perfect pass-through, the arithmetic (log) price effect of switching from 19% to 7% amounts to about -0.106. A larger(smaller) estimate of β implies under-shifting (over-shifting).¹⁹ We additionally augment the specification with group-by-date fixed effects, $\lambda_{g,t}$, which control for all group-specific time-varying confounders common to both countries. Further, we incorporate brand-by-country-by-month indicators to capture brand-country-specific seasonality. We base statistical inference in (1) and all subsequent specifications on robust two-way clustered standard errors allowing for cluster-dependence within product i and within brand b .

To gain better understanding of the timing of the pass-through and check for any intertemporal

¹⁹The Appendix provides a brief theoretical framework on the factors affecting the economic incidence of VAT changes.

shifting in sales, we employ an event study specification in relative time. Formally,

$$\ln Y_{i,g,c,t} = \alpha_i + \sum_{\substack{j=-12 \\ j \neq -7}}^{66} b_j \mathbf{I}(j = t - E_c) + \gamma_t + \lambda_{g,t} + \epsilon_{i,g,c,t}, \quad (2)$$

where $\mathbf{I}(k = t - E_c)$ equals one if at time t country c is j periods away from the event time (VAT reduction), and is zero otherwise. We consider a three-month window before the event and about 66 weeks after, and normalize the DiD estimation relative to the seventh week before enactment ($j = -7$) to allow for an early pass-through prior to the policy's official implementation.²⁰

Depending on the degree of substitutability, the assignment of feminine hygiene products to the reduced VAT rate may exert cross-price effects on other products. This seems likely, in particular, with regard to panty liners, which remain subject to the standard rate. To test for such effects, we estimate eq. (1) solely with product category [iii], i.e. liners. In this case, $\text{Treat}_{c,t}$ is assigned to equal one for liners in Germany starting from January 2020 and is zero otherwise. A $\beta < 0$ would be indicative of German consumers substituting towards the reduced-rated pads & tampons, and point to cross-price effects.

In case spillover effects on panty liners are absent, we can explore an alternative estimation approach that identifies the reform's effects only from the German data, i.e. Italy is excluded from the estimation. Specifically, the sales and prices of panty liners in Germany can serve as a control group for pads & tampons in Germany. Formally:

$$\ln Y_{i,g,t} = a_i + \widetilde{\theta \text{Treat}_{g,t}} + y_t + e_{i,g,t}, \forall i \in g, i \in c \setminus \{IT\} \quad (3)$$

where, $Y_{i,g,t}$ denotes the respective outcome variable, i.e. the *German* average price or total unit sales of product i belonging to group g in time t . a_i and y_t are product and time fixed effects. The group- and time-specific treatment indicator, defined as $\widetilde{\text{Treat}_{g,t}} := 1\{t \geq W1, 2020 \cup g = \{\text{Tampons, Pads}\}\}$ equals one for all pads & tampons from the first week of January 2020 onwards,

²⁰Note that the petition passed the federal parliament (Bundestag) in the second week of November, i.e. seven weeks before enactment.

and is zero otherwise. The treatment effect θ in this framework is identified from the differential tax status of groups $[i]$ - $[ii]$ versus $[iii]$ *within* Germany, so that units sales/prices of liners serve as counterfactuals for the developments in the sales/prices of pads & tampons in the absence of the VAT re-classification. As before, the identifying assumptions are a common trend assumption and the SUTVA, but this time pertaining to the sales and prices of panty liners in Germany. In some specifications, we also account for all time-varying confounders at the brand-date level. Note that estimating eq. (1) with product category $[iii]$ is a direct test of the SUTVA in (3).

Last, but not least, eqs. (1) and (3) can be combined into one in a triple difference (DDD) specification:

$$\ln Y_{i,g,c,t} = \tilde{\alpha}_i + \tilde{\beta} \text{Treat}_{c,g,t} + \sigma DE_c \times \text{Post}_t + \tilde{\lambda}_{g,t} + \tilde{\rho}_{b,t} + \tilde{\epsilon}_{i,g,c,t} \quad (4)$$

where DE is an indicator for Germany and Post is set to one after January 1st, 2020. $\tilde{\beta}$ in this framework is the triple-difference estimator and captures the difference in mean changes (before-after the VAT cut) in the unit sales/prices of tampons & pads in Germany and Italy net of the difference in mean changes in these outcomes for liners.²¹ In this specification, the treatment indicator varies by product group, by country, and over time such that $\text{Treat}_{c,g,t} := 1\{t \geq W1, 2020 \cup c = \{DE\} \cup g = \{\text{Tampons, Pads}\}\}$.²² As pointed out by Olden and Møen (2022), the advantage of the DDD estimator is that even if time-varying country-specific shocks challenge the parallel trend assumption in eq. (1), the *relative* unit-sales/price outcomes for tampons & pads and for liners are unlikely to be affected. In this model the maintained identifying assumption is therefore the absence of differential trends for tampons & pads versus liners within Germany relative to Italy.

²¹Specifically, $(\Delta T\&P_{DE} - \Delta T\&P_{IT}) - (\Delta \text{Liners}_{DE} - \Delta \text{Liners}_{IT})$, with $\Delta T\&P_{DE}$ being the before-after-event mean change in unit-sales/prices of tampons & pads in Germany.

²²Note that equation (4) can equivalently be written as $\ln Y_{i,g,c,t} = \beta_0 + \beta_1 DE_c + \beta_2 TP_g + \beta_3 \text{Post}_t + \beta_4 DE_c \times TP_g + \beta_5 DE_c \times \text{Post}_t + \beta_6 TP_g \times \text{Post}_t + \beta_7 DE_c \times TP_g \times \text{Post}_t + \tilde{\epsilon}_{i,g,c,t}$, where TP is a dummy for tampons & pads. Note that β_7 , the coefficient on the triple-interaction term, is the same as $\tilde{\beta}$. Given the fixed effects incorporated in eq. (4), the effects of DE , TP , and $DE \times TP$ are absorbed by $\tilde{\alpha}_i$, and those of Post and $TP \times \text{Post}$ – by $\tilde{\lambda}_{g,t}$.

5 Results

Price Effects. – Results from the estimation of specification (1) are reported in Table 3, with price effects shown in Panel A, and unit sales effects in Panel B. The specifications differ with regard to the product groups included and with regard to the time periods under consideration. The differentiation across product groups stems from the different tax treatment of tampons & pads (groups [i],[ii]) versus liners (group [iii]) as discussed in Section 4. The purpose of varying the estimation periods is to test the sensitivity of the results to shocks to the retail sector that occurred later in the year and after the VAT reclassification, which resulted in a permanently lower tax rate, was implemented. Specifically, in week 13 of the same year, i.e. end of March, Germany imposed a Covid-19 lock-down. In week 23, early June, Germany announced the lowering of both the standard and reduced VAT rates for a period of 6 months – starting on July 1st. Similarly to Germany, Italy enforced a lock-down in March 2020, and while introducing a series of small stimulus packages over time, it did not modify its consumption tax.²³ To use the above specifications for estimating the long-term pass-through of the VAT reclassification a year or so later, it would be necessary to assume that the specific lock-down measures were comparable across the two countries. Hence, we first provide estimates for a limited time period until March 2020. As robustness checks that explore further developments, we also show results based on an extended period until June 2020, and on a period until July 2021.²⁴ Since in the last case we capture the temporary VAT cut, in these specifications we include a set of period-specific indicators that capture differential developments until the end of the stimulus measure in December 2020.

Given that establishing design comparability across the multiple Covid-related measures in both countries is unfeasible, in specifications (1)-(3) we start out by removing weeks 11-52 in 2020 and year 2021 from the estimation. Because in such a setting a finding of incomplete pass-through could be either driven by retailers capturing some of the consumer surplus, or slow speed of price

²³Due to the pandemic, in May 2020 Italy withdrew (for a second time) a planned increase in its standard VAT rate from 22 to 25% and of its reduced rate from 10 to 12%, both scheduled to take place on January 1st, 2021.

²⁴To explore the development in the first phase of COVID more precisely, later on we also employ an event-study approach that enables us to consider differential developments in the time period after March 2020.

adjustment, in a second step we add back the 3.5 months before the stimulus-based VAT reform (mid-March to June). Lastly, we incorporate the full period of the sample with the caveats and assumptions made above, but explicitly control for the timing of the temporary VAT cut and its reversal to ensure that this measure does not confound the reclassification-induced price response. Specifically, we augment eq. (1) with two additional indicators: $\text{VAT Cut}_{c,t}$, which equals one from July 1st to December 31st 2020 in Germany and is meant to separate the effect of the temporary VAT cut from the reclassification, as well as $\text{VAT Reverse}_{c,t}$, which is set to one from the first week of January 2021 in Germany.

Based on column (1), two and a half months after the VAT law change, prices of tampons and pads in Germany are estimated to have decreased by 10 log points relative to those in Italy. Based on the confidence interval, we cannot reject a complete pass-through of the VAT change into consumer prices. Column (2) and subsequent specifications incorporate brand-by-country-by-month indicators, which control flexibly for country seasonality allowed to vary by brand. The point estimate is slightly lower, but both specifications reflect a close correspondence between the legal and economic incidence of the tax cut.

If tampons & pads are substitutes for panty liners, consumers may reduce consumption of the high-taxed group in favor of the reduced-rated products. In turn, prices of liners can also adjust in reaction to a tax cut affecting closely-related hygiene categories. Specification (3) tests for cross-price effects by contrasting prices and unit sales of liners in Germany to those in Italy before and after the reform. As discussed in Section 4, this estimation returns the average treatment effect on the non-treated product group by setting the treatment indicator $\text{Treat}_{c,t}$ to one for liners in Germany post January 2020, while using liners in Italy to form counterfactuals. The table shows that neither prices, nor unit sales of liners appear to respond to the tax cut with point estimates that are not statistically different from zero at conventional levels. Hence, the hypothesis that consumers switch between panty liners and tampons & pads as relative prices change is not supported.

In columns (4)-(5), the sample is extended up to week 26 in 2020, i.e. it incorporates the lock-down periods. Any differential price trends caused by diverging lock-down measures in Italy and Germany

Table 3: VAT reclassification: Pass-through into Prices and Unit Sales Response

Countries	DE & IT						
Period	Excluding March lock-down & July VAT cut			Excluding July VAT cut		Full	
Product groups	[i], [ii]	[iii]		[i],[ii]	[iii]	[i],[ii]	[iii]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
A. Prices							
$Treat_{c,t}$	-0.100*** (0.009)	-0.093*** (0.009)	0.000 (0.020)	-0.104*** (0.009)	0.016 (0.015)	-0.100*** (0.011)	0.023 (0.017)
$VAT\ Cut_{c,t}$						-0.049** (0.015)	-0.047* (0.023)
$VAT\ Reverse_{c,t}$						-0.022 (0.015)	-0.018 (0.015)
B. Unit Sales							
$Treat_{c,t}$	-0.306 (0.202)	-0.412 (0.291)	-0.420 (0.556)	-0.263 (0.287)	-0.361 (0.546)	-0.243 (0.293)	-0.413 (0.575)
$VAT\ Cut_{c,t}$						-0.249 (0.158)	-0.571** (0.209)
$VAT\ Reverse_{c,t}$						-0.280 (0.175)	-0.567*** (0.095)
$\lambda_{g,t}$	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\eta_{b,c,m}$		Yes	Yes	Yes	Yes	Yes	Yes
N (product-by-date)	85,499	85,488	45,331	101,140	53,756	151,113	79,476

Notes: The dependent variable is the log of price in Panel A, and the log of units sold in Panel B. The specifications refer to either product groups [i] pads and [ii] tampons, or to [iii] panty liners. Specifications (1)-(3) exclude the period from W11 to W52 in 2020, which covers the first Covid-19 lock-down and the VAT cut on July 1st, 2020 in Germany, as well as year 2021. Specifications (4)-(5) exclude W27 to W52 in 2020 and year 2021. Specifications (1)-(2), (4) and (6) are based on two product groups – pads and tampons in Italy and Germany, while specifications (3), (5) and (7) use a single product group – panty liners in the same two countries. All specifications include date(week-by-year) and product fixed effects, not reported, and are based on eq. (1). In (3), (5) and (7), the treatment indicator $Treat_{c,t}$ is set to equal one for panty liners in Germany from January 2020, in a pseudo-treatment specification. VAT Cut is an indicator for the VAT cut in Germany and is set to one from July 1st until December 31st, 2020. VAT Reverse is an indicator for the VAT reversing to the pre-reform rates in Germany and is set to one from January 1st, 2021. η_{bcm} are brand-by-country-by-month indicators. Robust standard errors are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

should correspondingly affect the average pass-through estimate. Coefficients remain very similar, however, indicating that initial lock-downs do not seem to exert confounding influence. Last but not least, specifications (6)-(7) of Table 3 include the full duration of the sample until mid-2021, but include the two additional treatment indicators. The identifying assumption is that post-tax cut, prices in Germany and Italy would have evolved similarly in the absence of the July VAT reduction and its subsequent reversal.

Column (6) reports an estimated average price decrease due to the reclassification of -10 log points, and due to the VAT cut – of -4.9 log points. Again, we cannot reject a full pass-through for the first reform, but, given the standard error, the later cut appears to be more than completely shifted into prices. We reject a β below -0.078 and above -0.019 at the 5% level.²⁵ Unlike the reclassification of feminine hygiene products to the lower tax rate, however, the temporary VAT cut is likely endogenous to economic conditions and as such its economic incidence cannot be cleanly separated from general pandemic-related trends. Nevertheless, our estimate suggests that another reclassification of feminine sanitary products from a reduced- to a zero-rated category has a potential to further increase their affordability. Table A-3 in the Appendix, in which the treatment indicators are interacted with a dummy for retailer brands shows that, while no differential pass-through emerges between national and retailer brands regarding the tax reclassification, the over-shifting of the temporary VAT cut appears to be driven by national brands.

With respect to panty liners, using the full sample in (7) again reveals a lack of price response to the tampons & pads' VAT reclassification as in (3) and (5), whereas the null of full pass-through of the standard rate cut cannot be rejected.²⁶ Regarding the VAT rate's reversal at the start of 2021, we do not find significant effects on prices, but as we will show later on, at least for panty liners, this is because the pass-through is largely completed before the official timing of the reversal.

Effects on Unit Sales. – From a theoretical perspective, the above findings of the effects of the tax

²⁵By July 1st, 2020, tampons and pads are subject to a reduced 7% VAT. The VAT cut, therefore, lowers the rate by 2 pp, to 5%, so that an estimate of -0.019 would be indicative of a full pass-through.

²⁶For panty liners, a VAT reduction of 3pp applies in July as they are subject to the standard VAT rate. Therefore, -2.6 log points would reflect full pass-through into prices for this product group.

reclassification are consistent with a case of fully inelastic demand.²⁷ Panel B of Table 3 provides supporting empirical evidence. In particular, across all specifications, the long-run effect of the policy on unit sales is not statistically different from zero not only for the treated tampons & pads, but also for panty liners. The latter result signals that liners are not considered to be close substitutes for tampons & pads. Demand for liners is found to decrease substantially around the time of the temporary VAT cut and especially after its reversal in 2021 as shown in column (7) of Panel B.

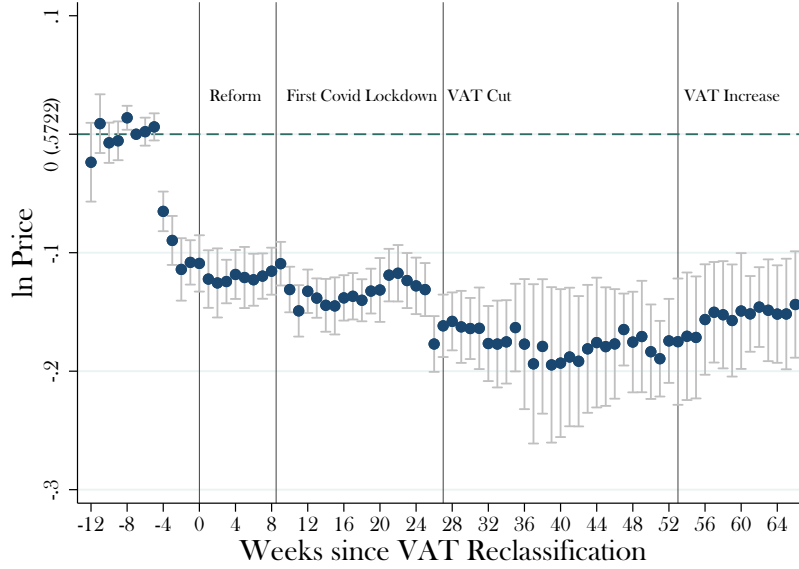
Dynamic Adjustment. – We next turn to the dynamic specification (2) to determine the speed and timing of the pass-through relative to enactment. Additionally, we check whether the lack of demand response is masking the presence of short-term intertemporal substitution effects, which can arise if some consumers delay the purchase of sanitary products in anticipation of a forthcoming price decline. Figure 1 visualizes the estimated time paths for prices of tampons & pads in Plot (a) and units sales in Plot (b), while Figure 2 presents similar plots for panty liners. The graphs additionally mark (vertical lines) the first week of the March lock-down as well as the duration of the VAT cut. Bearing in mind that normalization is relative to the 7th week prior to implementation, the price dynamics in Figure 1(a) evinces a swift and early pass-through starting in the first week of December 2019 that is largely completed by the second week of January. This development points to a quick reaction by retailers as the official approval of the tax decrease in the tax law occurred on 29th of November 2019.²⁸ By the end of December 2019, about 73% of the tax cut is already passed on to consumers. Price adjustment is complete within a month and a half. The response to the temporary VAT reduction appears to be even faster as the pass-through is effectively finalized within one week prior to implementation with prices staying at a lower level throughout the entire statutory duration of the policy. Reversal in 2021 seems sluggish and, at least in the first half of 2021, prices do not fully return to their pre-reform level. Figure 2(a) shows that prices of liners do not respond around the permanent tax cut, or the first lock-down. While the timing and speed of the pass-through of the temporary cut is identical to that of tampons & pads, prices of liners start to increase in November exhibiting an early and complete reversal prior to the official end date.

²⁷For a formal discussion see Appendix.

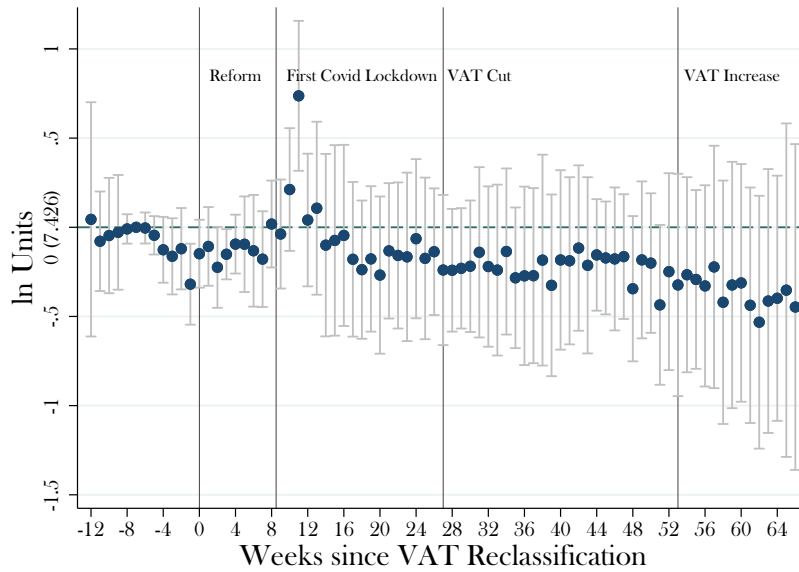
²⁸The VAT cut was first announced publicly on October 4th 2019 by the German Minister of Finance.

Figure 1: Tampons & Pads: Price and Unit-sales Dynamics around the Tax Reclassification

(a) Price pass-through (Tampons & Pads)



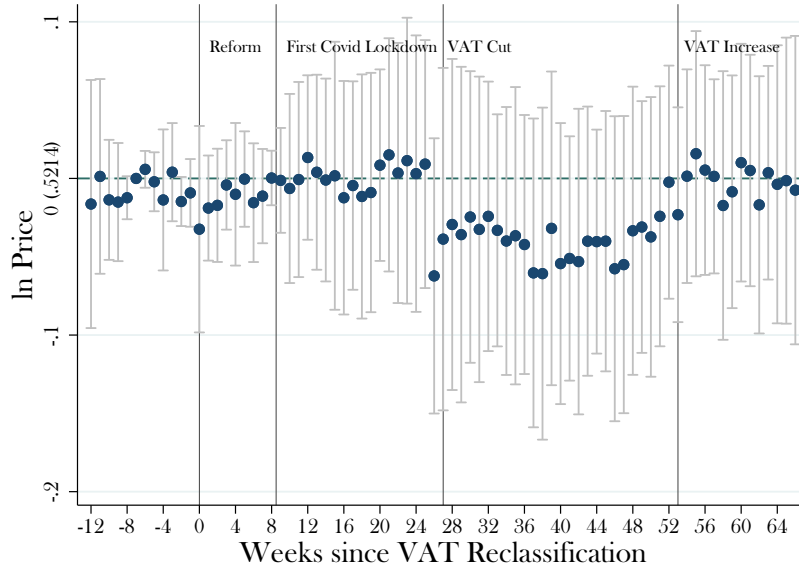
(b) Unit sales (Tampons & Pads)



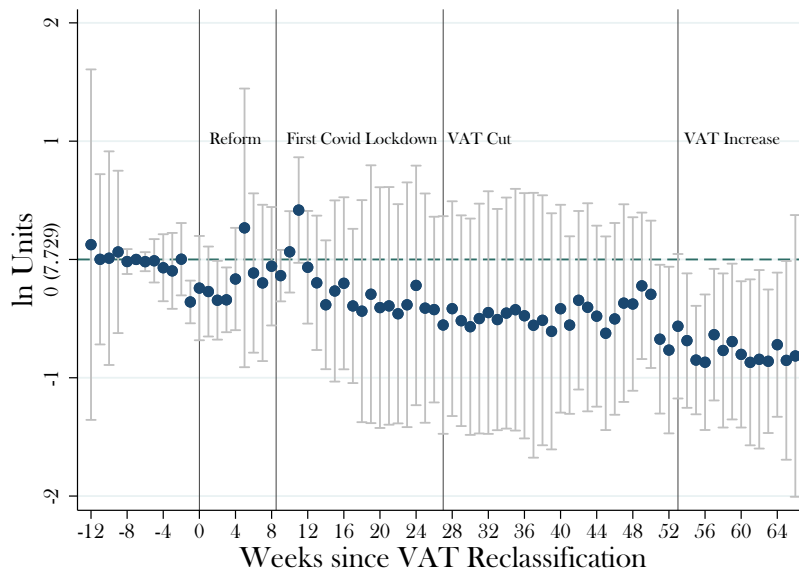
Notes: The figure traces the estimated time path along with pointwise 95% confidence intervals of the log price (Plot (a)) and of log units (Plot (b)) of tampons & pads twelve weeks prior to the VAT re-classification in Germany in January 2020, and 65 weeks after. The estimation reflects regression specification (2) using a standard TWFE estimator. Normalization is relative to event time $j = -7$. Both specifications control for product- and time-fixed effects as well as product group-by-country-specific linear time trends. The first vertical line designates the timing of the VAT reclassification, the second – the start of the first lock-down during the Covid-19 pandemic in Germany, which occurred on March 16th, 2020, the third line depicts the VAT cut, while the fourth shows its reversal in January 2021. Standard errors are two-way clustered by product and by brand. Coefficients are reported in detail in Table A-4 in the Appendix.

Figure 2: Panty liners: Price and Unit-sales Dynamics around the VAT Reclassification

(a) Price pass-through (Panty liners)



(b) Unit sales (Panty liners)



Notes: The figure traces the estimated time path along with pointwise 95% confidence intervals of the log price (Plot (a)) and of log units (Plot (b)) of panty liners twelve weeks prior to the VAT re-classification in Germany in January 2020, and 65 weeks after. The estimation reflects regression specification (2) where the treatment variable now equals one for panty liners in Germany from January 1st, 2020. Normalization is relative to event time $j = -7$. Both specifications control for product, and time fixed effects as well as product group-by-country-specific linear time trends. The first vertical line designates the timing of the VAT reclassification, the second the start of the first lock-down during the Covid-19 pandemic in Germany, which occurred on March 16th, 2020, the third line depicts the VAT cut, while the fourth shows its reversal in January 2021. Standard errors are two-way clustered by product and by brand. Coefficients are reported in detail in Table A-4 in the Appendix.

Table 4: Alternative Identification:
Price Pass-through and Unit-sales Responses

Countries	DE		
Period	Excluding March lock-down & July VAT cut		Excluding July VAT cut
Product groups	[i], [ii], [iii]		
	(1)	(2)	(3)
A. Prices			
$\widetilde{\text{Treat}}_{g,t}$	-0.108*** (0.017)	-0.090*** (0.020)	-0.107*** (0.009)
B. Unit Sales			
$\widetilde{\text{Treat}}_{g,t}$	0.102 (0.402)	-0.427 (0.225)	-0.371* (0.143)
$\rho_{b,t}$		Yes	Yes
N (product-by-date obs.)	56,421	56,392	66,439

Notes: The dependent variable is the log price in Panel A and log units in Panel B. The product groups included in the estimation are pads, panty liners and tampons in Germany. All specifications control for week-year (date) and product fixed effects, not reported, and are based on eq. (3). Specifications in columns (1)-(2) exclude the period from W11 to W52 in 2020, which covers the first Covid-19 lock-down and the VAT cut on July 1st, 2020 in Germany. Specification (3) excludes W27 to W52 in 2020. $\rho_{b,t}$ are brand-by-date fixed effects. Robust standard errors, in parentheses, are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Turning to Figure 1(b), the estimated time path of units sales does not exhibit deviations consistent with intertemporal shifting neither around the tax reclassification, nor around the temporary VAT stimulus, which corroborates the insignificant long-term estimates from (1). At the same time, however, we observe clear indication of a one-time stockpiling of feminine hygiene products during the lock-down, which is not accompanied by a decline in demand at a later point, possibly due to uncertainty about the general availability of these products during the pandemic. A similar jump in the sales of liners is visible between weeks 8 and 12 as displayed in Figure 2(b). Purchases are lower throughout the lock-down relative to the reference period, do not rise after the VAT cut, and decline further after the end of the VAT stimulus.

Table 5: Triple-difference Specifications

Countries	DE & IT		
Period	Excl. 1st lock-down & July VAT cut	Excl. July VAT cut	Full
Product groups	[i], [ii], [iii]		
	(1)	(2)	(3)
A. Prices			
$Treat_{c,g,t}$	-0.088*** (0.019)	-0.118*** (0.015)	-0.120*** (0.019)
DE×Post	0.004 (0.019)	0.027 (0.019)	0.011 (0.028)
B. Unit Sales			
$Treat_{c,g,t}$	0.060 (0.328)	0.193 (0.329)	0.369 (0.354)
DE×Post	-0.785 (0.509)	-0.825 (0.588)	-0.981 (0.648)
$\tilde{\lambda}_{g,t}$	Yes	Yes	Yes
$\tilde{\rho}_{b,t}$	Yes	Yes	Yes
N (product-by-date obs.)	130,055	153,967	229,204

Notes: The dependent variable is the log price in Panel A and log units in Panel B. The product groups included in the estimation are pads, panty liners and tampons in Germany and Italy. All specifications control for week-year (date) and product fixed effects, not reported, and are based on eq. (4). Specification in column (1) excludes the period from W11 to W52 in 2020, which covers the first Covid-19 lock-down and the VAT cut on July 1st, 2020 in Germany. Specification (2) excludes W27 to W52 in 2020, while specification (3) does not restrict the timing of the sample. $\tilde{\rho}_{b,t}$ are brand-by-date fixed effects and $\tilde{\lambda}_{g,t}$ are product group-by-date indicators. Robust standard errors, in parentheses, are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Alternative Identification. – In light of the lack of cross-price and demand effects on panty liners in Germany, in an alternative approach we utilize this category as a control group for treated sanitary products within Germany. One advantage of using eq. (3) for causal identification is that government interventions addressing the economic consequences of the pandemic do not vary across the three subgroups of feminine hygiene products. A limitation is that unlike eq. (3), in this setting we are unable to control for the effect of the July VAT reform as all product categories are affected at the same time. For this reason, the period of the VAT cut as well as 2021 are excluded from the estimation. The results from this exercise are reported in Table 4 and corroborate a full pass-through with coefficients of comparable magnitude to those in the benchmark approach. Including the lock-down period in (3) leaves the coefficients unchanged. Responses of units sales, shown in Panel B, again attest to a largely price-inelastic demand.

Table 5 reports results for triple-difference specifications. We impose the same sample restrictions as in the standard DiD framework. The magnitudes are similar even if somewhat smaller for the sample ending in March 2020 compared to the results in Tables 3 and 4, and slightly higher when the sample is extended to June 2020 (column (2)), or to mid-2021 (in column (3)). All price estimates are statistically significant, and our confidence intervals include a full pass-through of the tax reclassification. The associated coefficients for unit sales reported in Panel B corroborate our earlier findings of no adjustments in demand.

Heterogeneity. – We also check for differential price pass-through and demand effects along the price and market-share distributions by constructing market-share and price quantiles based on *pre-event* unit sales and prices per item, i.e. for the period 2018-2019. Products are allocated within one of three quantiles and this allocation is held constant for the entire duration of the panel. Effectively, therefore, this exercise excludes products entering the market for the first time in 2020 or 2021.²⁹ Using eq. (1), we interact the treatment indicator, $Treat_{c,t}$ with dummies for the respective quantiles. Results are reported in Table 6 for prices in Panel A, and unit sales in Panel B. Varying the duration of the panel until the timing of the lock-down or up until the temporary VAT stimulus,

²⁹185 products (91 Germany; 94 Italy) first appear in the panel in 2020, which we assume is their year of market entry, while this number is 83 (37 Germany; 47 Italy) in 2021.

as before, shows no heterogeneity in the pass-through across products with low/high market shares (columns (1) and (3)), and no differential impacts on demand (columns (5) and (7)). With respect to effects along the price distribution, both specifications (2) and (4) point to most expensive products (quantile 3) having a smaller pass-through than their cheaper counterparts. Nonetheless, effect gets weaker once the time period is extended, so we cannot preclude that full pass-through simply takes longer for these products.³⁰

Revenue Effects. – The above results show that the reduction in the VAT by assigning pads/tampons to the reduced VAT rate is fully passed on to the consumer. Furthermore, as there is no evidence of a change in consumer behavior and since other products of the same product group are unaffected, the results suggest that the direct total consumer benefit is equivalent to the revenue loss. Given that the data covers approximately the full market for feminine hygiene products in Germany, we can provide an estimate of the foregone annual revenue as a result of the permanent tax cut. Total expenditure on tampons & pads in Germany in 2020 is 296.2 million Euro.³¹ Adjusting prices in the dataset in 2020 by multiplication with 1.19/1.07 yields counterfactual prices inclusive of 19% VAT, such that total expenditure in 2020 in the absence of the tax reclassification would have been 329.4 million. This amounts to an aggregate cost of the policy of 33.2 million Euro in foregone revenue per year, or 0.014% of the total VAT revenue collected in Germany in 2019. This number fits well with the revenue estimate of the Ministry of Finance (BMF) that calculated the revenue loss from applying the reduced rate at 35 million Euro.³²

6 Conclusion

This paper examines the incidence of taxes on feminine hygiene products using the recent 12pp. tax cut of the general sales tax (VAT) on these products in Germany as a natural experiment. Our

³⁰Similar results using our alternative identification strategy are reported in Table A-5 in the Appendix, while Figure A-2, also in the Appendix, visualizes results if the sample is split into ten market-share and price-per-item quantiles.

³¹The respective number for 2019 is 323.4 million.

³²Following the petition, the assignment of feminine hygiene products to a reduced rate was brought through the parliament only as an amendment to an existing bill. The BMF's revenue estimate was therefore only communicated to the Members of the Parliament. Details on how the revenue estimate was obtained are not available.

Table 6: Heterogeneity along the Market-share and Price Distributions

Countries	DE & IT							
Period	Excluding March lock-down & July VAT cut		Excluding July VAT cut		Excluding March lock-down & July VAT cut		Excluding July VAT cut	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	A. Prices				B. Unit Sales			
$Treat_{c,t}$	-0.093*** (0.014)	-0.095*** (0.007)	-0.102*** (0.016)	-0.107*** (0.007)	-0.315 (0.260)	-0.238 (0.135)	-0.129 (0.251)	-0.002 (0.113)
$Treat_{c,t} \times ms_q2$	-0.006 (0.016)		-0.007 (0.019)		-0.049 (0.171)		-0.105 (0.155)	
$Treat_{c,t} \times ms_q3$	0.004 (0.013)		0.001 (0.014)		-0.170 (0.157)		-0.199 (0.128)	
$Treat_{c,t} \times price_q2$		-0.002 (0.007)		0.001 (0.006)		-0.135 (0.141)		-0.244 (0.147)
$Treat_{c,t} \times price_q3$		0.014*** (0.004)		0.010* (0.004)		-0.494 (0.281)		-0.644* (0.296)
N (product-by-date)	85,403	85,403	100,670	100,670	85,403	85,403	100,670	100,670

Notes: The dependent variable is the log of price in Panel A, and the log of units sold in Panel B. Specifications (1)-(2) and (5)-(6) exclude the period from W11 to W52 in 2020, which covers the first Covid-19 lock-down and the VAT cut on July 1st, 2020 in Germany as well as 2021. Specifications (3)-(4) and (7)-(8) exclude W27 to W52 in 2020 as well as 2021. Estimation is based on eq. (1). All specifications include date(week-by-year), product-, product group-by-date, and brand-by-country-by-month fixed effects (not reported). Country-specific and product-group-specific market shares are constructed on the basis of sales in 2018-2019. Products are then split into three quantiles (ms_q1, ms_q2, and ms_q3) based on market shares, with best-sellers positioned in the third quantile. Similarly, we generate three quantiles (price_q1, price_q2, and price_q3) based on the pre-treatment (2018-2019) *price per item* distribution. Most expensive products are positioned within the third price quantile. Robust standard errors are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

results indicate that the tax cut is completely shifted into prices. Across different product categories, quantities purchased do not show any effects of the tax cut pointing to a fully inelastic demand. A medium-term exploration of price dynamics reveals that prices of tampons & pads in Germany remain below the pre-event baseline at least 1.5 years after the reform pointing at lasting changes in affordability.

Our findings contribute towards resolving the current controversy surrounding proposals to reduce or completely eliminate the tampon tax. As policy makers need to take revenue losses into account, the prospect of an unsuccessful reform that leaves consumer prices unchanged could deter them from revising tampon taxes at worst, or could lead to delays in approaching the issue at best. The empirical results show that reducing sales taxes on feminine hygiene products can be an effective way to enhance the affordability of these products and hence combat period poverty. The move of feminine hygiene articles to a low- or zero-taxed category of consumer goods thus has the potential to promote a meaningful change in vulnerable women and girls' socio-economic participation and status. Whether such a change actually occurs and what are further mechanisms behind it besides affordability are important questions for future research.

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Appendix

Taxes and Gender Equality: The Incidence of the ‘Tampon Tax’

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Tax Incidence in Theory

Under perfect competition, the extent to which taxes on feminine hygiene products are reflected in prices depends on the supply and demand elasticities. In the presence of a substitute taxed at a regular rate, the cross-price elasticity matters as well.

Consider a model with two goods X and Y , where good Y is subject to a specific commodity tax τ . Assuming that supply only hinges on the producer prices Q and P , supply functions are

$$y_t = \epsilon^{SY} p_t + v_t^{SY} \quad (\text{A.5})$$

$$x_t = \epsilon^{SX} q_t + v_t^{SX}, \quad (\text{A.6})$$

where lower case letters denote logs of the respective variable. Invoking the “Ramsey exclusion restriction”, the demand hinges on the tax-inclusive price ([Zoutman, Gavrilova, and Hopland, 2018](#)). Hence, demand functions are

$$y_t = \epsilon^{DY} p_t + \epsilon^{DY} \log(1 + \tau_t) + \epsilon^{DYZ} q_t + v_t^{DY} \quad (\text{A.7})$$

$$x_t = \epsilon^{DX} q_t + \epsilon^{DXY} p_t + \epsilon^{DXY} \log(1 + \tau_t) + v_t^{DX} \quad (\text{A.8})$$

The system of four equation (A.5)-(A.8) can be rearranged as a reduced form:

$$y_t = -\delta \left(\frac{\epsilon^{SY}}{\epsilon^{DY} - \epsilon^{SY}} \right) \left(\epsilon^{DY} + \frac{1 - \delta}{\delta} \right) \log(1 + \tau_t) + u_t^Y \quad (\text{A.9})$$

$$p_t = -\delta \left(\frac{1}{\epsilon^{DY} - \epsilon^{SY}} \right) \left(\epsilon^{DY} + \frac{1 - \delta}{\delta} \right) \log(1 + \tau_t) + v_t^Y \quad (\text{A.10})$$

$$x_t = \delta \left(\frac{\epsilon^{SX} \epsilon^{DXY}}{\epsilon^{DX} - \epsilon^{SX}} \right) \left[\left(\frac{\epsilon^{DY}}{\epsilon^{DY} - \epsilon^{SY}} \right) - 1 \right] \log(1 + \tau_t) + u_t^X \quad (\text{A.11})$$

$$q_t = \delta \left(\frac{\epsilon^{DXY}}{\epsilon^{DX} - \epsilon^{SX}} \right) \left[\left(\frac{\epsilon^{DY}}{\epsilon^{DY} - \epsilon^{SY}} \right) - 1 \right] \log(1 + \tau_t) + v_{it}^X, \quad (\text{A.12})$$

where $\delta = \left[1 - \left(\frac{\epsilon^{DXY}}{\epsilon^{DY} - \epsilon^{SY}} \right) \left(\frac{\epsilon^{DXY}}{\epsilon^{DX} - \epsilon^{SX}} \right) \right]^{-1}$. Equation (A.9) provides a prediction for the effect of the tax rate on the amount of sales of the taxed commodity. Equation (A.10) provides the corresponding effect on the producer price.

In a standard case, where $\epsilon^{SY} > 0$ and $\epsilon^{DY} < 0$, if the cross-price elasticity on the non-taxed commodity is zero $\epsilon^{DXY} = 0$, $\delta = 1$, a decrease in the specific commodity tax τ is associated with an increase in the amount of sales Y and the producer price P . The incidence critically depends on the strength of the increase of the producer price. Noting that the consumer price is $(1 + \tau_t) P_t$, the effect on the log consumer price is given by

$$\frac{d \log((1 + \tau_t) P)}{\log(1 + \tau_t)} = 1 - \left(\frac{\epsilon^{DY}}{\epsilon^{DY} - \epsilon^{SY}} \right) = - \left(\frac{\epsilon^{SY}}{\epsilon^{DY} - \epsilon^{SY}} \right).$$

Hence, under the simplifying assumptions, we have the usual result that the incidence depends on the supply and demand elasticities. Moreover, as noted by [Zoutman, Gavrilova, and Hopland \(2018\)](#), these structural parameters can be recovered from the reduced form parameters.

In the presence of cross-price effects $\epsilon^{DXY} \neq 0$, further assumptions are needed to identify the structural form. Note, however, that the reduced form relationships between the non-taxed good and the tax rate helps us to test for possible cross-price effects. As equations (A.11) and (A.12) indicate, the tax rate will only exert effects on the non-taxed good's price or sales provided that $\epsilon^{DXY} \neq 0$.

Table A-1: Product Characteristics by Category

Category	Features
Pads	Absorbency and size (Mini (lowest)(0.01), Normal (11.45)/Regular (27.67), Normal-Plus (1.69)/Long (6.61), Night (3.81)/Night-Plus (0.73)/Night-Plus-extra (highest) (0.04)); Thickness (Ultra) (43.23); Mixed (A mix of different absorbency and size levels) (4.75).
Tampons	Absorbency (Mini (lowest)(10.53), Normal(27.22), Super(16.07), Super-Plus (Highest)(7.76)); Application (with Applicator(21.64), Digitali(15.99)); Mixed (A mix of different absorbency levels)(0.78)
Panty Liners	Absorbency (Light-Normal(43.95)/Normal(24.14), Large(14.64)/Long(1.3)/Strong(7.68)); Shape (Multiform(3.46), Flexicomfort(2.88)); Thickness (Ultra-thin)(1.95).

Notes: The table lists the product characteristics in the data pertaining to each product category. Numbers in parentheses are shares of products with the respective characteristic in the sample for each product category.

Table A-2: Descriptive Statistics by Product Type and Country: Full Sample

	Mean	Std. Dev.	Min	Max	N
A. Germany					
Pads & Tampons					
Price	2.058	1.259	0.217	10.96	59,160
Price per item	0.101	0.115	0.005	1.392	59,160
Units (Packs)	8,659	17,016	1	273,784	59,160
Volume	205,282	478,187	2	11,200,000	59,160
Items per pack	28.34	20.36	2	80	59,160
Liners					
Price	1.858	0.909	0.01	7.03	38,459
Price per item	0.043	0.029	0.0003	0.250	38,459
Units (Packs)	9,954	17,081	1	170,080	38,459
Volume	456,673	823,578	5	9,272,981	38,459
Items per pack	47.86	24.14	5	280	38,459
B. Germany, excluding retailer brands					
Pads & Tampons					
Price	2.834	1.288	0.478	10.96	26,692
Price per item	0.154	0.147	0.015	1.392	26,692
Units (Packs)	9,054	20,790	1	273,784	26,692
Volume	232,792	635,918	7	11,200,000	26,692
Items per pack	25.33	17.88	3	72	26,692
Liners					
Price	2.435	0.805	0.010	7.03	21,915
Price per item	0.051	0.022	0.0003	0.200	21,915
Units (Packs)	9,374	18,739	1	170,080	21,915
Volume	477,735	955,790	20	9,272,981	21,915
Items per pack	53.92	28.97	18	280	21,915
C. Italy					
Pads & Tampons					
Price	2.983	2.407	0.100	19.8	92,000
Price per item	0.175	0.110	0.009	1.275	92,000
Units (Packs)	3,919	11,823	0.33	217,508	92,000
Volume	56,412	157,334	7	2,271,103	92,000
Items per pack	18.24	14.39	7	112	92,000
Liners					
Price	2.775	1.933	0.24	19.9	41,056
Price per item	0.074	0.043	0.004	0.430	41,056
Units (Packs)	2,733	8,009	0.88	103,453	41,056
Volume	99,058	311,590	15.0	4,551,937	41,056
Items per pack	44.67	41.33	10	240	41,056

Notes: The table shows summary statistics per product per week per product-group averaged over time and products. The statistics refer to the period 2018-2021. Volume is unit packs times the number of individual pads/tampons/liners within a pack. Prices are inclusive of VAT. Panel A summarizes the entire German market, while Panel B excludes retailer brands. Panel C summarizes the Italian market, excluding retailer brands, which are not available at the product level.

Table A-3: VAT reclassification: National vis-a-vis Retailer Brands

Countries	DE & IT		DE	
Period	Full		Excluding July VAT cut	
Product groups	[i], [ii]		[i], [ii], [iii]	
	Prices (1)	Units (2)	Prices (3)	Units (4)
$Treat_{c,t}$	-0.089*** (0.015)	-0.459 (0.460)		
$Treat_{c,t} \times RetailB$	-0.020 (0.012)	0.376 (0.406)		
$VAT\ Cut_{c,t}$	-0.072*** (0.017)	-0.066 (0.137)		
$VAT\ Cut_{c,t} \times RetailB$	0.043** (0.015)	-0.313** (0.106)		
$VAT\ Reverse_{c,t}$	-0.039 (0.023)	-0.204 (0.290)		
$VAT\ Reverse_{c,t} \times RetailB$	0.033 (0.025)	-0.140 (0.272)		
$\widetilde{Treat}_{g,t}$			-0.091*** (0.017)	-0.423 (0.341)
$\widetilde{Treat}_{g,t} \times RetailB$			-0.027 (0.017)	0.084 (0.341)
$\lambda_{g,t}$	Yes	Yes	No	No
$\eta_{b,c,m}$	Yes	Yes	No	No
$\rho_{b,t}$	No	No	Yes	Yes
N (product-by-date)	151,113	151,113	66,439	66,439

Notes: The dependent variable is the log of price in specifications (1) and (3), and the log of units sold in (2) and (4). Estimation is based on eq. (1) in (1)-(2) for the full duration of the sample, and on eq. (3) in (3)-(4), for a sample adjusted to exclude W27 to W52 in 2020 and year 2021. *RetailB* is a dummy variable equal to one for retailer brands. Robust standard errors are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-4: Pass-through and Unit-sales Responses: Event Study Estimates

<i>j</i>	Tampons & Pads				Panty liners			
	Prices		Unit Sales		Prices		Unit Sales	
	(1)		(2)		(3)		(4)	
	Coeff.	S.e.	Coeff.	S.e.	Coeff.	S.e.	Coeff.	S.e.
-12	-0.024	0.017	0.044	0.328	-0.016	0.039	0.125	0.737
-11	0.009	0.012	-0.078	0.139	0.001	0.031	0.001	0.358
-10	-0.007	0.008	-0.046	0.161	-0.014	0.019	0.011	0.449
-9	-0.006	0.008	-0.028	0.161	-0.015	0.019	0.064	0.341
-8	0.014**	0.005	-0.009	0.041	-0.012	0.007	-0.018	0.052
-6	0.002	0.006	-0.004	0.043	0.006	0.006	-0.019	0.040
-5	0.006	0.006	-0.045	0.054	-0.002	0.009	-0.011	0.091
-4	-0.065***	0.008	-0.126	0.092	-0.014	0.022	-0.070	0.141
-3	-0.090***	0.010	-0.163	0.107	0.004	0.016	-0.097	0.160
-2	-0.114***	0.013	-0.120	0.114	-0.015	0.008	0.002	0.152
-1	-0.108***	0.009	-0.319**	0.113	-0.009	0.011	-0.359***	0.090
0	-0.109***	0.012	-0.148	0.095	-0.032	0.033	-0.242	0.219
1	-0.122***	0.012	-0.107	0.110	-0.019	0.017	-0.271	0.189
2	-0.126***	0.015	-0.225	0.113	-0.017	0.018	-0.345*	0.166
3	-0.124***	0.009	-0.151*	0.070	-0.004	0.014	-0.341*	0.136
4	-0.118***	0.010	-0.094	0.082	-0.010	0.023	-0.165	0.215
5	-0.121***	0.013	-0.095	0.134	-0.000	0.015	0.267	0.586
6	-0.123***	0.011	-0.132	0.156	-0.015	0.019	-0.115	0.335
7	-0.120***	0.010	-0.179	0.134	-0.011	0.015	-0.198	0.329
8	-0.116***	0.010	0.018	0.122	0.000	0.009	-0.057	0.249
9	-0.109***	0.009	-0.038	0.152	-0.001	0.017	-0.137	0.108
10	-0.131***	0.010	0.212	0.172	-0.006	0.030	0.064	0.171
11	-0.149***	0.011	0.737***	0.210	-0.001	0.031	0.418	0.222
12	-0.133***	0.009	0.041	0.186	0.013	0.026	-0.066	0.237
13	-0.138***	0.008	0.107	0.242	0.004	0.031	-0.198	0.282
14	-0.144***	0.011	-0.100	0.255	-0.001	0.032	-0.383	0.271
15	-0.145***	0.012	-0.074	0.266	0.002	0.043	-0.267	0.381
16	-0.138***	0.010	-0.046	0.253	-0.012	0.037	-0.201	0.362
17	-0.137***	0.010	-0.179	0.216	-0.005	0.033	-0.393	0.324
18	-0.140***	0.009	-0.238	0.193	-0.012	0.039	-0.437	0.467
19	-0.132***	0.009	-0.177	0.203	-0.009	0.038	-0.294	0.542
20	-0.131***	0.013	-0.268	0.220	0.008	0.030	-0.407	0.506
21	-0.119***	0.011	-0.132	0.189	0.015	0.037	-0.392	0.500
22	-0.117***	0.012	-0.158	0.204	0.003	0.041	-0.459	0.461
23	-0.124***	0.012	-0.166	0.236	0.011	0.045	-0.383	0.514
24	-0.128***	0.012	-0.064	0.223	0.003	0.044	-0.219	0.504
25	-0.131***	0.011	-0.175	0.226	0.009	0.039	-0.411	0.482
26	-0.177***	0.012	-0.137	0.177	-0.062	0.044	-0.424	0.390
27	-0.162***	0.013	-0.240	0.210	-0.039	0.054	-0.554	0.458
28	-0.158***	0.012	-0.241	0.172	-0.029	0.053	-0.416	0.451
29	-0.163***	0.015	-0.230	0.168	-0.036	0.053	-0.518	0.443
30	-0.164***	0.013	-0.219	0.184	-0.025	0.046	-0.569	0.455
31	-0.164***	0.017	-0.140	0.238	-0.033	0.049	-0.500	0.483
32	-0.177***	0.016	-0.220	0.224	-0.024	0.043	-0.449	0.510
33	-0.177***	0.018	-0.240	0.239	-0.033	0.037	-0.508	0.465
34	-0.175***	0.018	-0.136	0.232	-0.040	0.043	-0.453	0.486

Table continues on next page

Table A-3: Pass-through and Unit-sales Responses: Event Study Estimates, contd.

Table A-4 continued from previous page

35	-0.163***	0.018	-0.283	0.197	-0.037	0.047	-0.425	0.508
36	-0.177***	0.027	-0.272	0.250	-0.042	0.041	-0.476	0.516
37	-0.194***	0.034	-0.271	0.245	-0.060	0.049	-0.556	0.557
38	-0.179***	0.028	-0.184	0.295	-0.061	0.053	-0.514	0.525
39	-0.195***	0.033	-0.325	0.254	-0.032	0.050	-0.608	0.496
40	-0.193***	0.031	-0.183	0.251	-0.054	0.045	-0.416	0.437
41	-0.188***	0.029	-0.188	0.234	-0.051	0.039	-0.555	0.373
42	-0.192***	0.027	-0.116	0.231	-0.053	0.049	-0.345	0.375
43	-0.181***	0.027	-0.213	0.247	-0.040	0.043	-0.404	0.437
44	-0.176***	0.027	-0.155	0.156	-0.040	0.036	-0.479	0.380
45	-0.179***	0.025	-0.172	0.158	-0.040	0.041	-0.624	0.407
46	-0.177***	0.023	-0.177	0.200	-0.058	0.048	-0.502	0.403
47	-0.165***	0.015	-0.164	0.174	-0.055	0.047	-0.369	0.415
48	-0.175***	0.021	-0.344	0.203	-0.033	0.046	-0.377	0.365
49	-0.171***	0.023	-0.183	0.220	-0.031	0.040	-0.223	0.308
50	-0.184***	0.020	-0.201	0.195	-0.037	0.044	-0.295	0.310
51	-0.189***	0.016	-0.435	0.224	-0.024	0.041	-0.674*	0.313
52	-0.174***	0.018	-0.249	0.275	-0.002	0.037	-0.766*	0.350
53	-0.175***	0.027	-0.323	0.311	-0.023	0.034	-0.565	0.304
54	-0.171***	0.027	-0.266	0.273	0.001	0.034	-0.686*	0.283
55	-0.172***	0.026	-0.292	0.250	0.016	0.039	-0.850***	0.228
56	-0.156***	0.023	-0.329	0.282	0.005	0.033	-0.869**	0.285
57	-0.150***	0.021	-0.222	0.339	0.001	0.031	-0.636*	0.277
58	-0.152***	0.023	-0.420	0.341	-0.017	0.043	-0.769*	0.324
59	-0.157***	0.024	-0.324	0.345	-0.009	0.037	-0.694*	0.327
60	-0.149***	0.024	-0.312	0.332	0.010	0.038	-0.802*	0.307
61	-0.152***	0.016	-0.437	0.329	0.005	0.037	-0.870*	0.349
62	-0.146***	0.017	-0.532	0.354	-0.017	0.041	-0.844*	0.375
63	-0.149***	0.021	-0.413	0.369	0.004	0.034	-0.861**	0.302
64	-0.152***	0.021	-0.398	0.343	-0.004	0.044	-0.721*	0.303
65	-0.152***	0.023	-0.353	0.467	-0.001	0.045	-0.853*	0.418
66	-0.144***	0.022	-0.447	0.456	-0.007	0.049	-0.815	0.592
N		117,375		117,375		57729		57729

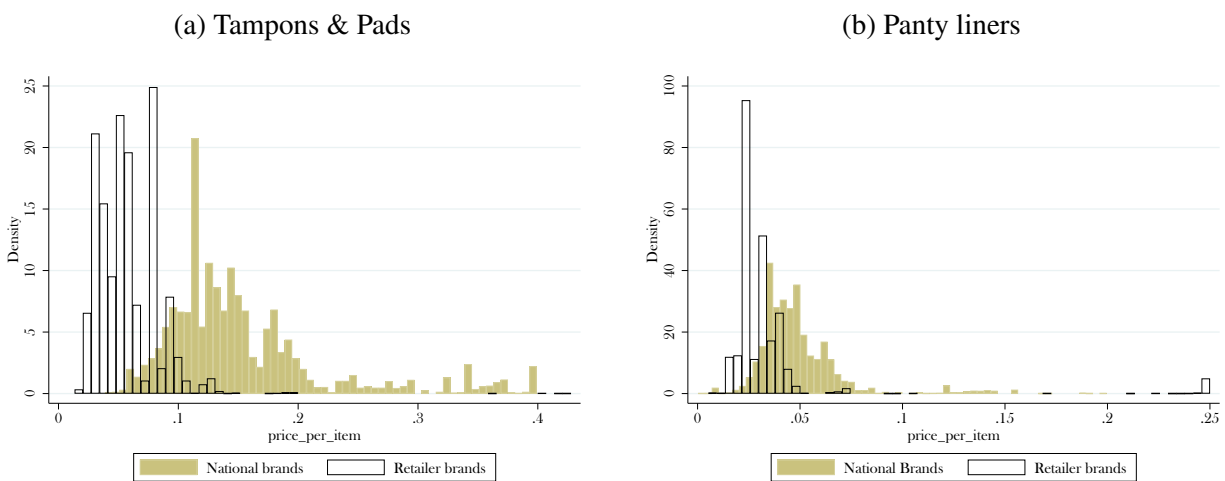
Notes: The dependent variable is the log price in (1) and (3) and log units in (2) and (4). Estimation is based on the event-study specification in (2), where specifications (1)-(2) are based on tampons & pads in Germany and Italy, and (3)-(4) – on panty liners in Germany and Italy. j is relative time to treatment, where the coefficient in the 7th week before treatment ($j = -7$) is normalized to zero. N is the total number of product-by-date observations. Robust standard errors, reported next to point estimates, are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-5: Heterogeneity along the Market-share and Price Distributions: Second Method

Countries	DE							
Period	Excluding March lock-down & July VAT cut		Excluding July VAT cut		Excluding March lock-down & July VAT cut		Excluding July VAT cut	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Prices				Unit Sales			
$Treat_{g,t}$	-0.089*** (0.016)	-0.093*** (0.008)	-0.105*** (0.009)	-0.105*** (0.004)	-0.331 (0.197)	-0.278* (0.112)	-0.254 (0.141)	-0.151* (0.066)
$Treat_{g,t} \times \widetilde{ms_q2}$	-0.008 (0.010)		-0.010 (0.008)		-0.308** (0.085)		-0.331* (0.129)	
$Treat_{g,t} \times \widetilde{ms_q3}$	0.009 (0.008)		0.005 (0.005)		0.094 (0.150)		0.049 (0.123)	
$Treat_{g,t} \times \widetilde{price_q2}$		-0.013*** (0.001)		-0.013*** (0.001)		-0.135* (0.044)		-0.173*** (0.033)
$Treat_{g,t} \times \widetilde{price_q3}$		0.014 (0.013)		0.002 (0.006)		-0.202 (0.176)		-0.312* (0.119)
N (product-by-date)	56,273	56,273	65,771	65,771	56,273	56,273	65,771	65,771

Notes: The dependent variable is the log of price in Panel A, and the log of units sold in Panel B. Specifications (1)-(2) and (5)-(6) exclude the period from W11 to W52 in 2020, which covers the first Covid-19 lock-down and the VAT cut on July 1st, 2020 in Germany as well as 2021. Specifications (3)-(4) and (7)-(8) exclude W27 to W52 in 2020 as well as 2021. Estimation is based on eq. (3). All specifications include date(week-by-year), product-, and brand-by-date fixed effects (not reported). Product-group-specific market shares are constructed on the basis of sales in 2018-2019. Products are then split into three quantiles ($\widetilde{ms_q1}$, $\widetilde{ms_q2}$, and $\widetilde{ms_q3}$) based on market shares, with best-sellers positioned in the third quantile. Similarly, we generate three quantiles ($\widetilde{price_q1}$, $\widetilde{price_q2}$, and $\widetilde{price_q3}$) based on the pre-treatment (2018-2019) *price per item* distribution. Most expensive products are positioned within the third price quantile. Robust standard errors are two-way clustered by product and by brand. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Figure A-1: Pre-treatment Price Distributions of National and Retailer Brands in Germany

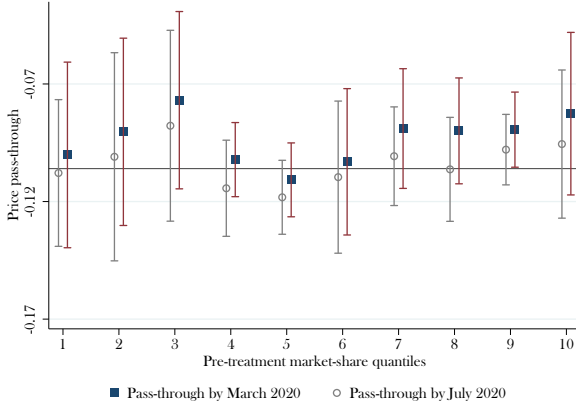


Notes: The figure displays price-per-item distributions comparing national and retailer brands in Germany for pads & tampons in (a) and panty liners in (b). The time period is 2018-2019.

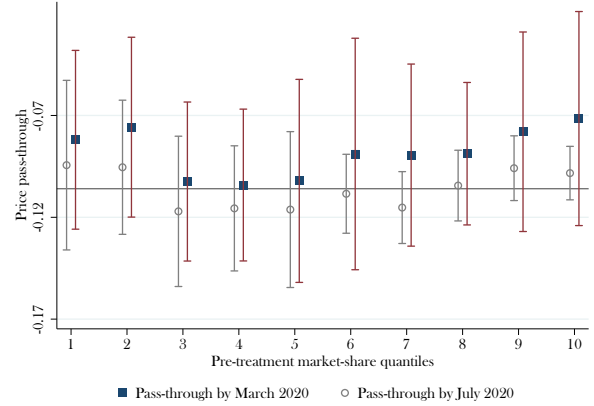
Figure A-2: Price Pass-through Heterogeneity

A. By Market-share Quantiles

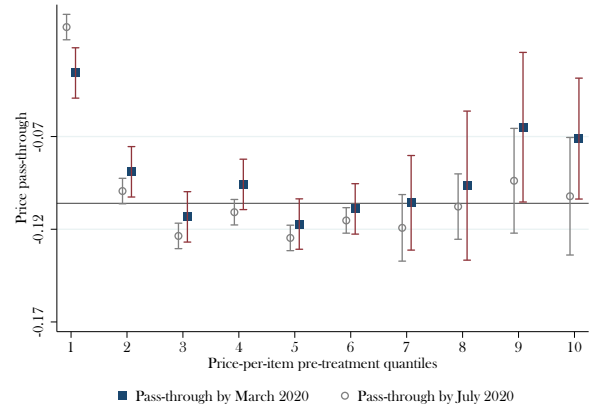
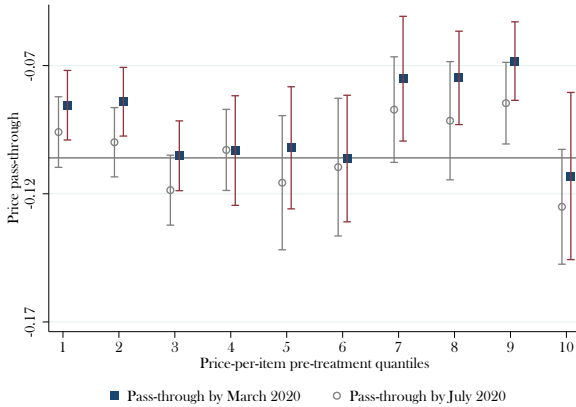
(a) Based on eq. (1)



(b) Based on eq. (3)



B. By Price-per-item Quantiles



Notes: Panel A shows the estimated pass-through by ten pre-treatment market-share quantiles, and Panel B – by ten pre-treatment price-per-item quantiles. Estimation in left-hand-side plots is based on eq. (1), while in right-hand-side plots – on eq.(3). Market-share and price quantiles in (a) are generated in the same way as described in the main text and note to Table 6, but are more detailed (10). Similarly, market-share and price quantiles in (b) are constructed in the same way as described in the main text and note to Table A-5.