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VAT Pass-Through: The Case of a Large and Permanent Reduction in the Market for Menstrual Hygiene Products

Abstract

This paper is about the price effects caused by a VAT (value-added tax) reduction for menstrual hygiene products in Germany. Several aspects make this VAT reduction particularly interesting: The exogeneity of the reduction under otherwise constant economic conditions, the reduction was substantial and permanent, demand for the products is inelastic and in many cases, pass-through rates are more than 100 percent. We find that the VAT reduction is completely passed through to consumers. Despite this complete pass-through, we still detect a significant effect of retailer competition: When more retailers offer a product, the price reduction is larger.

JEL-Codes: H220, H250, H320, K340.

Keywords: VAT reduction, pass-through, hygiene products, retailer competition.

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1 Introduction

Changes in value-added tax (VAT) rates have always been an issue surrounded by intense political debates. According to Enache (2022) more than 170 countries worldwide levy a VAT on (many) goods and services. Among these 170 countries, many – including all European countries – have at least two different VAT rates: the standard rate and a reduced rate. Some countries, such as, e.g., France, Italy, and Spain, even have a super-reduced rate. Moreover, a few countries in Europe also apply a so-called parking rate, which falls between the reduced and the standard rate. As a consequence, countries such as, e.g., Ireland currently apply four different VAT rates.

The question which goods and services are taxed under which rate is typically highly political. The main reasons for applying a reduced VAT rate are based on equity and distributional concerns. Typically, basic goods and services such as food and public transport are taxed at the reduced rate, as lower-income households tend to spend a larger share of income on these goods and services. However, other considerations also play a role such as the promotion of cultural goods (e.g., books) or local industries (e.g., tourism). In Germany, for example, a major political scandal erupted when the hotel and restaurant association successfully lobbied the Government to reduce the VAT for accommodation services from the standard rate 19 percent to the reduced rate of seven percent.

In more recent times, changes in the VAT have become even more popular among politicians. For example, during the recent pandemic the VAT in Germany was reduced for a limited period from 1 July to 31 December 2020 in order to provide an economic stimulus. The standard tax rate fell from 19 to 16 percent, and the reduced tax rate from seven to five percent.[1] In addition, the VAT for restaurant meals was reduced for an even longer period of time (to support restaurants) as was the VAT rate for long-distance train rides permanently reduced (for ecological reasons). Most recently, a VAT cut for natural gas has been announced in Germany

[1] See e.g., Fuest et al. (2021) and the references therein.

and Minister of Agriculture has proposed to increase the VAT rate for meat so as to induce consumers to eat less of it. Hence, changes in VAT rates have become quite frequent.

A major debate around these VAT rate changes is always the question of how much of any cut or increase is being passed through to end users. Our paper adds to this debate by studying one particular VAT cut which received particular attention both in the media as well as in political circles. On 1 January 2020, the VAT on menstrual products, such as tampons, was reduced from 19 to seven percent, following a widely publicized petition to the German parliament.

Several countries as well as single states of the US have applied a similar tax policy favoring menstrual hygiene products in recent years.[2] The reduction was implemented in order to remove a previous tax discrimination: Since only women purchase these hygiene products, they are more strongly affected by the VAT.[3]

Several aspects make this VAT reduction particularly interesting. First, the change can be considered exogenous in the sense of not being triggered by market conditions. There were no changes in supply or demand that led policymakers to adopt the policy. The VAT reduction can be seen as a natural experiment caused by an exogenous shock. Second, the VAT reduction was substantial. The tax rate was reduced from 19 (the general VAT rate in Germany) to seven percent (the reduced VAT rate imposed on some necessary products[4]). The reduction by 12 percentage points is relatively large compared to other changes in VAT which often amounted to very few percentage points. Third, and in contrast to other VAT policies observed in recent years, this tax rate reduction was imposed permanently.

[2]For example, in Kenya, Canada, India, Malaysia, and Australia there is no VAT on period products as well as in the US states of Nevada, New York, Florida, Connecticut, and Illinois (see Zraick, 2019; Buchholz, 2020; Masterson, 2022). Also, different European countries, for example Belgium, Cyprus, France, the Netherlands, Spain, and UK have changed the VAT rate applied to menstrual hygiene products to a reduced VAT (see online the Taxes in Europe Database (TEDB)). Since 2006, it has been legally permissible for EU member states to apply only a reduced VAT rate to menstrual hygiene products (see e.g., OJ L 347, 11.12.2006).

[3]For more information on why this can be interpreted as sex-based discrimination from a legal perspective see e.g., Eskitaşçıoğlu (2019); Crawford & Spivack (2019).

[4]Some products and services classified as basic needs, e.g., staple foods, books, flowers, and medical pacemakers, but also cultural activities or public transport, are subject to a reduced VAT rate.

This is in contrast to general reductions of VAT which are temporary in nature, for example, to support the economy in general.[5] Fourth, since the tax was reduced, ex ante stockpiling does not make any sense (unlike in the case of an announced tax increase). However, postponing demand is also unlikely for biological reasons. The demand for these products can thus be assumed to be inelastic within common price ranges, not least because there is no acceptable way to substitute these products. The inelasticity of demand implies that the tax incidence falls entirely on consumers and the net sales prices are theoretically unaffected. The VAT reduction should accordingly be fully forwarded to the consumer. These characteristics make the 2020 VAT reduction an interesting case study.

The change in the VAT rate for menstrual hygiene products was preceded by a large online petition demanding the reduction. The accusation of discriminating taxation drew a lot of public attention for the request to reduce VAT for menstrual hygiene products. It was a success story of online petitions in Germany.[6] The petitions were supported by various celebrities and various companies such that there was relatively high attention paired with frequent media coverage for this topic.[7]

Our research question is how the VAT reduction affected final consumer prices. Given the public attention for this rather emotionalized topic, it seems likely that retailers would pass on all of the savings to consumers. The inelastic demand also suggests that the reduction should be fully passed on to consumers from a theoretical perspective. But what will the data say? Moreover, is there any indication that competition between retailers matters for the pass-through?

The analysis in this paper uses a very rich dataset comprising a large part of the supply side (major supermarkets and most drugstores). We investigate how

[5]Like the general temporary VAT reduction from 19 to 16 (and from seven to five percent for necessary products) in Germany from July to December 2020.

[6]Two petitions were started in 2018 and 2019, which were both signed by far more people than necessary, such that the German parliament, the Bundestag, had to handle the request.

[7]Besides being covered by national magazines and newspapers, the international media also reported on the activities to demand a tampon tax rate reduction. The innovative and professional campaigning of the supporters drew attention to the topic e.g., with guerrilla marketing activities like a book containing tampons, as books were already taxed with the reduced rate (Flood, 2019).

the gross prices of tampons and sanitary pads changed within a time period that includes the official decision to reduce the VAT as well as the date when it came into force (the actual event).

We find that retailers passed through the whole VAT reduction and actually reduced prices by even more than the VAT change. Additionally, we detect a significant competition effect of retailers reducing prices more if more retailers offered a product.

2 Related Literature

This paper mainly contributes to the literature on VAT rate changes. There is a broad literature on VAT change effects on consumer prices analyzing the pass-through to the consumers. However, these studies mostly focus on the VAT change as a fiscal instrument (e.g., Blundell (2009) and Crossley et al. (2009) on the UK temporary VAT cut in 2008 and 2009). Also, in recent studies the VAT decrease is analyzed foremost in terms of the intended stimulus, like the temporary VAT reduction during the pandemic in Germany in 2020 (Montag et al. (2021) and Fuest et al. (2021)).

While we only study a VAT decrease, there is evidence that prices respond differently to increases and decreases. Doyle Jr & Samphantharak (2008), Carbonnier (2008) and Benzarti et al. (2020) analyze differences in tax incidence within increases and decreases. While Doyle Jr & Samphantharak (2008) find symmetric price responses for short-term interventions, Carbonnier (2008) and Benzarti et al. (2020) identify asymmetries comparing the effects of VAT increases in contrast to VAT decreases. According to Benzarti et al. (2020) prices respond less to a VAT decrease than to a VAT increase.

The effects of permanent VAT changes have mostly been studied when all consumer products are concerned (e.g., Benedek et al. (2020) and D'Acunto et al. (2022)). However, the effects on specific markets have also been analyzed. For example, the effects of a permanent VAT decrease for services like hairdressing

or housing repairs and also for costly products like new cars have been studied (e.g., Carbonnier (2007) and Kosonen (2015)). Compared to these products and markets, menstrual hygiene products are in a very different price range and, as already mentioned, have a very inelastic demand.

In addition, this paper offers empirical insights related to the theoretical discussion about the role of competition for pass-through. Besides demand elasticity, competitive pressure in a market is also related to the VAT pass-through. Weyl & Fabinger (2013) find that it is ambiguous whether pass-through under monopoly is higher or lower than pass-through under perfect competition. Fuest et al. (2021) found evidence that in product markets with only a few suppliers the price decrease by a temporary VAT rate cut was less pronounced than in product markets with many suppliers.

Additionally, this paper contributes to the small literature on menstrual hygiene products and taxation. Cotropia & Rozema (2018) also studied the effect of the elimination of sales taxes on menstrual hygiene products. They used consumer panel data from New Jersey in 2005 and used a diff-in-diff analysis to identify the effects on different consumer groups, e.g., differentiated by income and educational background. Cotropia & Rozema (2018) found that the tax break was passed on completely to consumers but was not distributed equally between different groups. Furthermore, Rüll (2020) studied different strategies on how the tax burden on menstrual hygiene products could be reduced. Also focusing on the possibility whether to promote sustainable products and discourage companies along the supply chain to not increase the profit margin when the tax burden is decreased. For a more recent survey on different tax policies and the effects on affordability of menstrual hygiene products focusing on low- and middle-income countries, see Rossouw et al. (2020).

3 Chronology, Data, and Empirical Strategy

Our dataset covers all policy-relevant stages for the VAT reduction. The weekly gross prices for all offered brand products of the types tampon and sanitary pad are analyzed using a before-and-after approach to identify the price effects of the VAT reduction.

3.1 Chronology

The observed time period covers all stages with policy-relevant decisions for the VAT reduction. These are the main events in the policymaking process:

- Starting with week number (WN) 42 (10/14/2019), the dataset includes the week when the draft law was released (WN 43, 2019).
- Plus the week when the final vote in the German Bundestag took place (Thursday of WN 45, 2019),
- and the week when the Bundesrat approved the new tax law (Friday of WN 48) are included.
- The date when the legislative amendment officially came into force was January 1, 2020 (WN 1).

More details on the chronology can be found in Appendix A.

3.2 Data

Our dataset[8] contains the gross prices for all offered brand products of the types tampon and sanitary pad of nine large German retailers[9] including leading drugstores, discounters, and supermarkets. The prices are reported on a weekly basis for 21 weeks, namely from WN 42 in 2019 and WN 10 in 2020 (inclusive) at the national

[8]Provided by a market participant and therefore anonymized.

[9]As retailers have been anonymized we do not provide further information on their identity, or about alternative distribution channels or more narrow characteristics.

level. The retailers included in our dataset serve about 60 percent of the demand for hygiene products and 40 percent of the grocery retailing in the German market.

Differentiating by the official product identification number (Global Trade Item Number, GTIN), there are 303 unique products in both of the product types: 109 tampons and 194 sanitary pads. Using product names, these can be categorized within the product type regarding the size of the tampons and sanitary pads as well as the number of items per package and other qualitative product characteristics.

For each product type one brand name can be identified as being the market leader (see below), in the following named "LTMB" for the leading tampon manufacturer brand and "LSMB" for the leading sanitary pad manufacturer brand. Both are by far the most popular brands among consumers. It should also be noted that tampons are the most commonly used technology (see VuMa, 2020).

In our data 96 tampon-type products belong to the LTMB, which means 88.1 percent of the different tampon products belong to this supplier. In the sanitary pad-type products, 168 of 194 products belong to the LSMB, representing a share of 86.6 percent. The share of retailers offering only one brand, the leading manufacturer brand in stock, is around 50 percent in our data.

There are various sizes and packages for both product types. The most frequently offered tampon size is "normal" followed by the size "super", then the less often supplied "super plus" and with some more distance "mini". The normal size is mostly sold in packs of 16, as is the super size. More than 40 percent of all packages stocked include 16 tampons. The share of normal size tampons in a pack of 16 is 16.8 percent and this is the most frequently offered tampon package.

In the sanitary pads segment most of the products have "wings" and are followed by the "normal" sized sanitary pads. Whereas the sanitary pads with wings are mainly offered in a pack of 18 the sanitary pads of the size normal are sold in a 14 pack. Although the differentiation within the technologies is limited, there is a rich variety of size and package size combinations.

3.3 Empirical Strategy

We conduct an event study defining a dummy-variable taking the value 1 for periods after the treatment. Therefore, we distinguish in our analysis the prices before WN 49 (excluding week 49) in 2019 as the "before" treatment period and the prices after WN 1 (excluding week 1) in 2020 as the "after" treatment period. The turn of the year was Tuesday to Wednesday such that WN 2 was the first full week of the year 2020.

Thus, there are seven weekly observations before and nine observations after the identified transition period. We work with this distinction using a before-and-after approach to determine the relative price change caused by the official decision to reduce VAT and its introduction. Our approach can be formulated as follows:

$$price_{i,t} = \beta_0 + \sum_t \beta_t \cdot VAT\ \ Reduction_t + a_i + u_{i,t} \tag{1}$$

with $price_{i,t}$ representing the logarithmic prices of different identified product-retailer-combinations i fluctuating over time t. The variable $VAT\ \ Reduction_t$ indicates the VAT reduction as a before-and-after dummy. This dummy is interacted with others in the further analysis.

Apart from the identification of the relative price effect for this product group, the focus of our analysis lies on the effect depending on the competitive setting. In further analyses, we disentangle the effects for the different technologies as well as differentiating between the store types.

4 Results

We start with a graphical approach to the aggregated prices in the market, also differentiating for the two product groups before we proceed with the more detailed analysis of the effects. Afterwards, the focus lies on competition effects as well as a retailer-level analysis. Finally, we close the analyses with a distinction between different product sizes and package sizes.

Unless otherwise stated, we perform panel regressions that include product fixed effects and report bootstrapped standard errors in our analysis. Unless otherwise indicated, all tests reported are post-regression Wald tests with the corresponding p-value.

4.1 Main Results

4.1.1 Overview and comparison to CPI

The effects of the VAT reduction are already evident from a look at the aggregated price data. Figure 1 visualizes the absolute average gross prices for menstrual products and highlights the important interweekly transitions. The left and middle vertical line indicate WN 47 and 49 in 2019 whereas the right line marks the second week after the turn of the year when the VAT reduction had come into force. The figure shows the immediate reaction of the retailers to the approval of the law.[10]

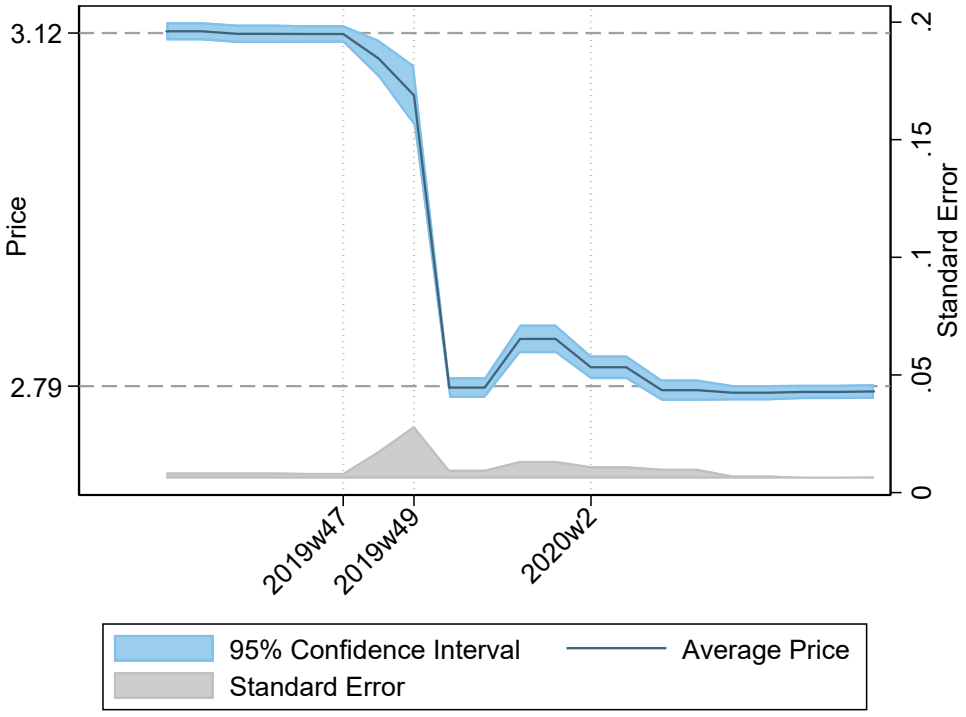

Figure 1: Aggregated Prices for Menstrual Products

[10]See also the Lebensmittelzeitung, an industry portal for the grocery retail and consumer goods industry focusing on Germany, of 12/10/2019 (Klug, 2019).

Even before the official date of the VAT reduction, prices started to drop. As expected[11], the policy change was finalized on the Friday of WN 48. The largest interweekly price drop at the aggregate level can be observed between WN 49 and WN 50. The price drop is complete by WN 2 in 2020, when the VAT was reduced.

The gray area shows the variation between prices over time. We can see that there was less variation in prices before the VAT cut than both between the weeks when prices were adjusted and when the reduction was officially in place. However, total variation appears to be relatively small, as the size of standard error indicates.

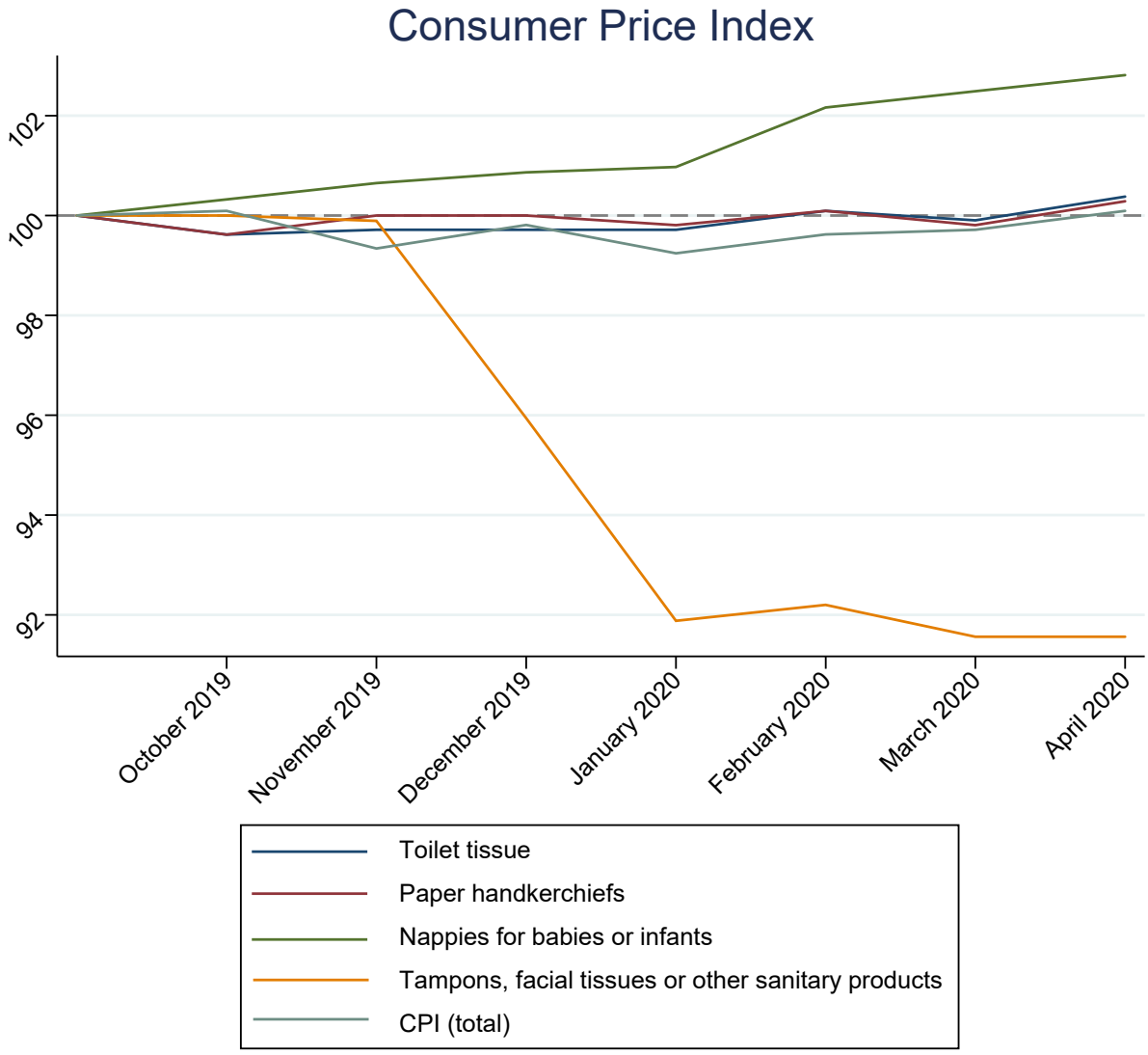

Figure 2: Consumer Price Index for assorted consumer goods for personal care; Base 09/2019; Data source:(Statistisches Bundesamt (Destatis), 2022).

[11]The agenda for the meetings of the Bundesrat is announced 10 days in advance.

The observed price drop is not the result of a general price shock, as Figure 2 shows. While similar products with respect to primarily used inputs remain at the same price level as before or even show upward tendencies, the yellow line in Figure 2 shows a clear drop between November 2019 and January 2020. This price decrease is almost certainly the result of the VAT reduction for this product group.[12]

4.1.2 All products

The benchmark for the VAT reduction is 10.084 percent: Since the prices in the dataset include VAT, the tax reduction for menstrual hygiene products from 19 to seven percent corresponds to a gross price reduction of 10.084 percent for each product affected by the VAT cut. Therefore, a price reduction of 10.084 percent corresponds to a 100 percent pass-through.

When we adopt a log-level approach we can interpret the estimated coefficients (β_j) for dummy variables only as an approximation of the true marginal effect. The formula $(e^{\beta_j} - 1) \cdot 100$ gives the exact percentage change. Therefore, an estimated coefficient of -0.1063 corresponds to our benchmark of a gross price reduction of 10.084 percent.

Table 1 shows for all products the absolute and relative price reduction that was observed after the VAT change in comparison to the period before the legal approval. The aggregated price effect for consumers induced by the reduction in VAT is a absolute saving of 33.2 euro cents per pack of menstrual hygiene products (see regression (1) and also Figure 1). This implies a relative price reduction of 11.38 percent for the joint market of tampons and sanitary pads (regression (2)). Overall, we observe that the VAT reduction was more than fully passed through to consumers.

[12]The selected categories are: Tampons, facial tissues, and other sanitary products which include menstrual hygiene products, toilet tissues, paper handkerchiefs, and nappies for babies or infants. The products of these categories are mainly cellulose-based. Therefore, we can exclude an overlaying price trend caused by input factor prices for the tampon, facial tissues, and other sanitary products category. Further, a large share of the products in these categories can be assumed to be necessities. Besides the similarity in input factors, demand for these products is rather stable.

Table 1: Price effects at the aggregated level – absolute & relative

	(1) Absolute Price	(2) Relative Price
VAT Reduction	-0.332***	-0.121***
	(0.00346)	(0.000912)
Constant	2.987***	1.032***
	(0.0327)	(0.0117)
Fixed Effects	✓	✓
Observations	12930	12930

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.1.3 Two product groups

When we separate the two product groups, we find that the reduction for sanitary pads is significantly higher ($p = 0.05$, Wald Test) than for tampons. Separating for the two most frequently used technologies in Germany (regressions (1) and (2)) in Table 2 reveals a nearly two percentage point reduction difference between the price effects. Whereas the prices for sanitary pads were reduced by 12.09 percent, the effect for the much more frequently used tampon technology led to a reduction of only 10.37 percent. However, both reductions significantly exceed (for tampons $p = 0.05$ and for sanitary pads $p = 0.01$, Wald Test) the benchmark of 10.084 percent mentioned above.

Figure 3 shows the relative price effects separated by the technologies over the observed time horizon for all products in the data. The graphs indicate that the VAT reduction was more than fully passed-through, although we note differences between the two product groups. Tampon prices show more variation, both before and after the price reduction, but also relatively after the VAT change.

Table 2: Price effects at the aggregated level – separating by product groups

	Sanitary Pads	Tampons
VAT Reduction	-0.129***	-0.110***
	(0.00145)	(0.000613)
Constant	0.952***	1.144***
	(0.0166)	(0.0172)
Fixed Effects	✓	✓
Observations	7515	5415

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

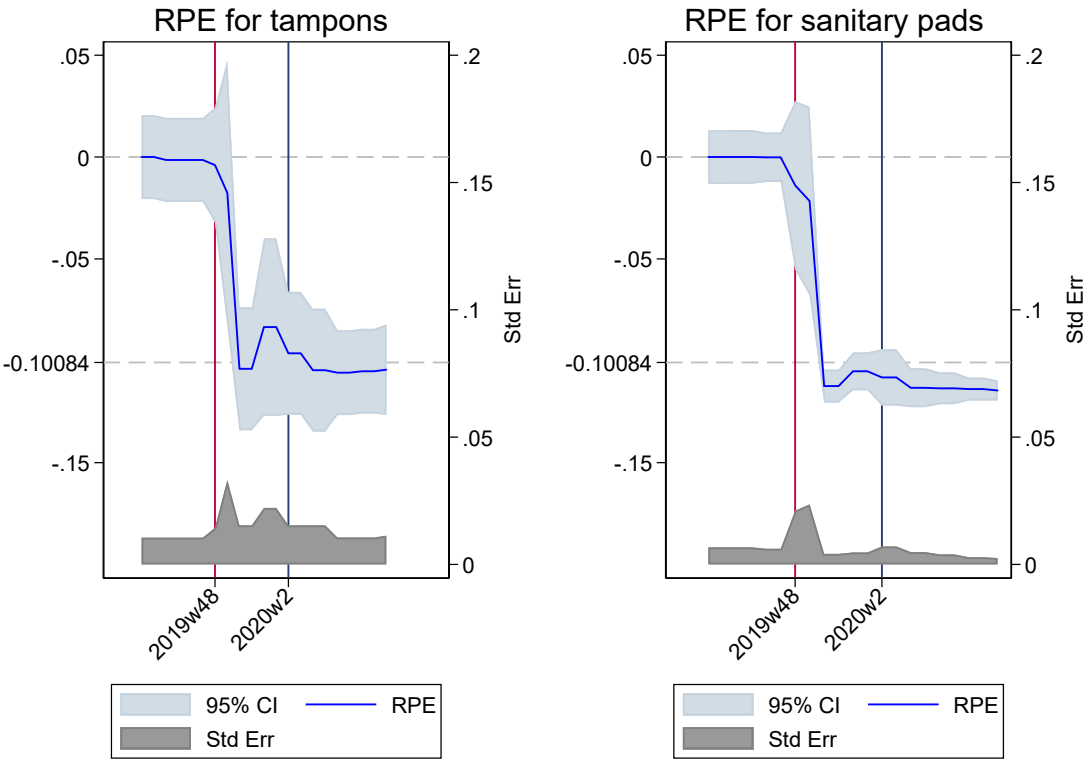

Figure 3: Relative price effect (RPE) for sanitary pads and tampons

4.2 Competition Effects

4.2.1 Retailer Competition

We measure competition with respect to the number of retailers offering a certain product. Products offered in just one retailer are referred to as without competition while products which we find in two or more retailers as with competition. The degree of pass-through differs depending on the number of retailers offering the product. However, the reduction was fully forwarded in all cases, with and without competition.

Figure 4 compares the relative VAT pass-through for products that are offered by one retailer and products that are offered by more than one retailer. While the VAT pass-through without competition meets the 100 percent benchmark, the prices for those products which are offered by more than one retailer exceed the 100 percent pass-through rate by 15.4 percentage points.

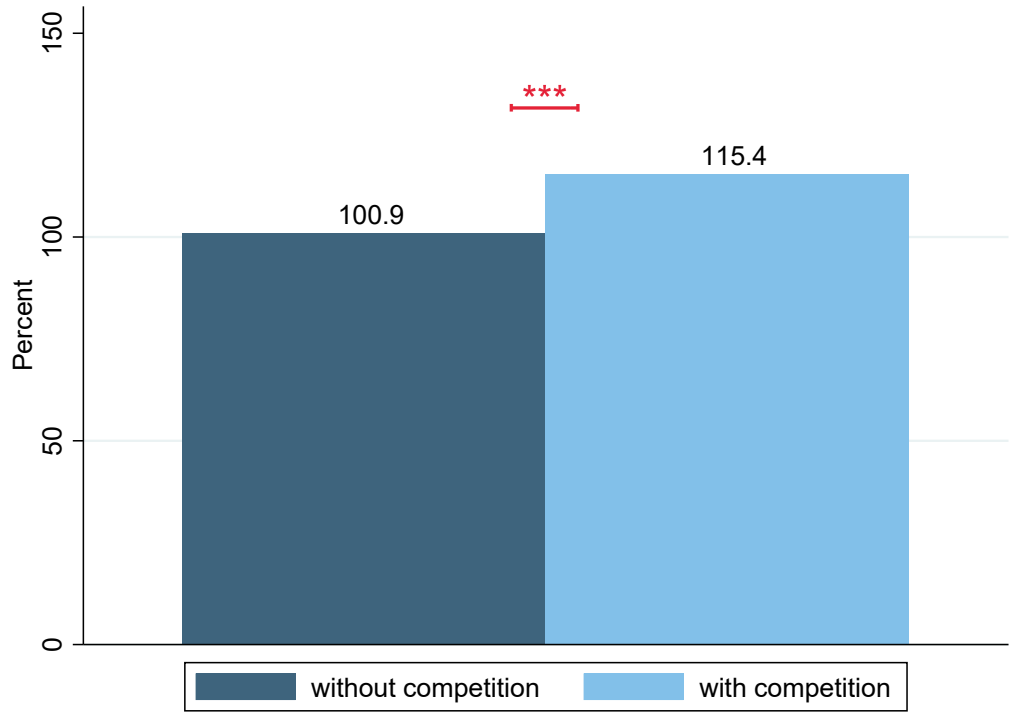

Figure 4: VAT pass-through with and without competition

Table 3, column (1) shows the relative price reduction due to the VAT change with competition, which was, on average, by 1.46 percentage points more reduced than without competition. Columns (2) and (3) show the reduction separated by the two technologies. The reduction in the sanitary pads segment significantly exceeds the reduction in the tampon segment with competition ($p = 0.01$, Wald Test) by 1.3 percentage points.

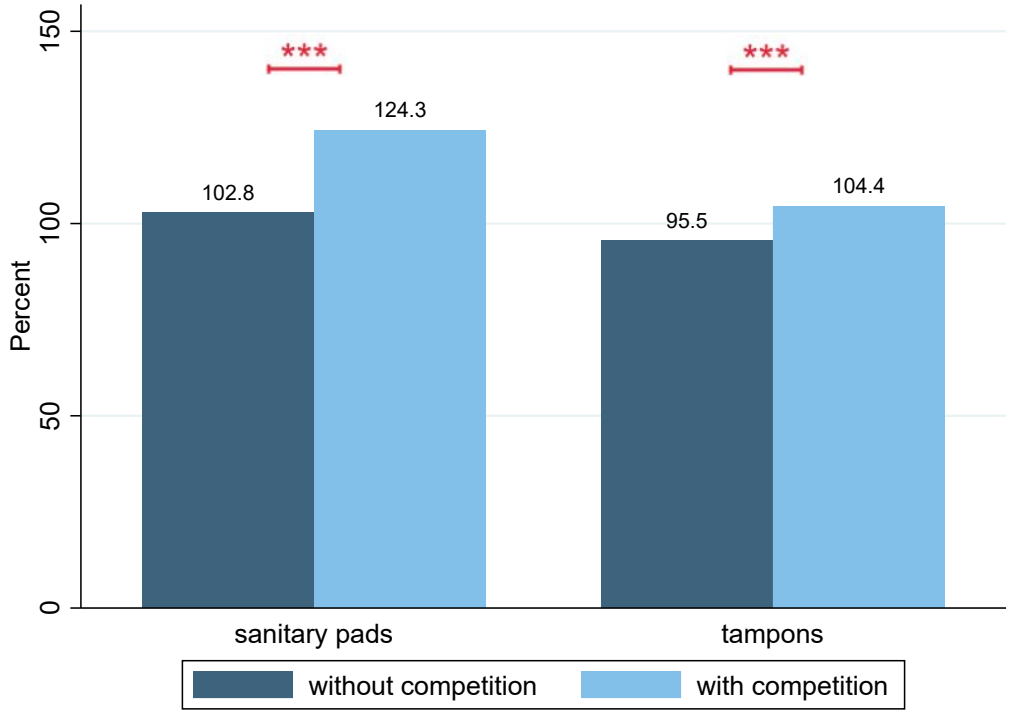

Figure 5: VAT pass-through with and without competition – two product types

We disentangle this competition effect further for the number of retailers in Appendix C.3, Table 17 and the corresponding Figure 10. As the dataset does not comprise the complete supply side, this number has to be interpreted as a proxy for the true number of retailers. However, for the same reason, some of the products which are stocked at just one retailer here, might actually be offered by more than one in the whole market. As a result, the estimate when just one retailer offers a product can be interpreted as an upper boundary of the relative price effect. As we observe an upward bias in our estimate for one retailer, the

real difference between one and more than one retailer stocking a product must be larger than our results suggest.

Table 3: Relative price effects with and without competition

	all	sanitary pads	tampons
VAT Reduction	-0.107***	-0.109***	-0.101***
	(0.00240)	(0.00284)	(0.00363)
VAT Reduction × competition	-0.0147***	-0.0219***	-0.00867*
	(0.00252)	(0.00322)	(0.00370)
Constant	1.032***	0.952***	1.144***
	(0.0117)	(0.0166)	(0.0172)
Fixed Effects	✓	✓	✓
Observations	12930	7515	5415

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In Appendix C.3, we also show that the effect of retailer competition holds for both technologies separately and differs between the product groups, as indicated by other results. Table 18 shows that the reduction is less for tampons in comparison to sanitary pads. We also control for brand effects in tables 20 and 22, and for sanitary pads and tampons in tables 19 and 21.

4.2.2 Brand Competition

We can also compare intra-brand competition between retailers within the leading manufacturer brands. Although products from the leading manufacturer brands constitute the lion share of observations in our dataset, the relative numbers between the leading manufacturer brand and other brands in the market differ with respect to the number of retailers offering the product. As Figures 6 and 7 illustrate: Products from the leading manufacturer brands are, on average, offered by more different retailers than the other brand products.

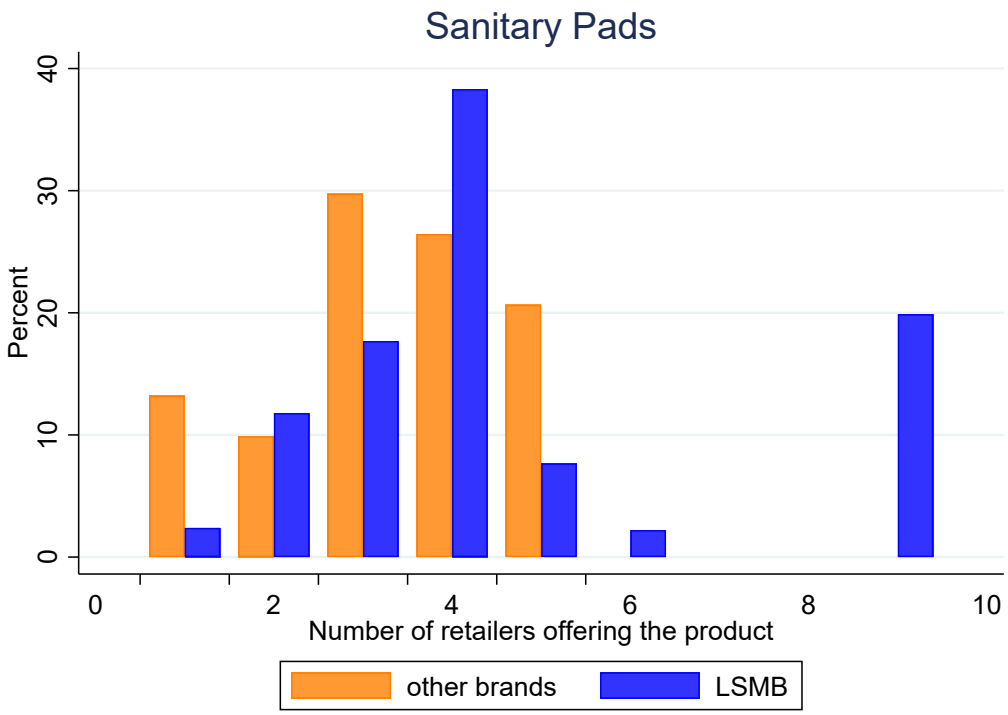

Figure 6: Share of LSMB and other brands by number of retailers offering the product

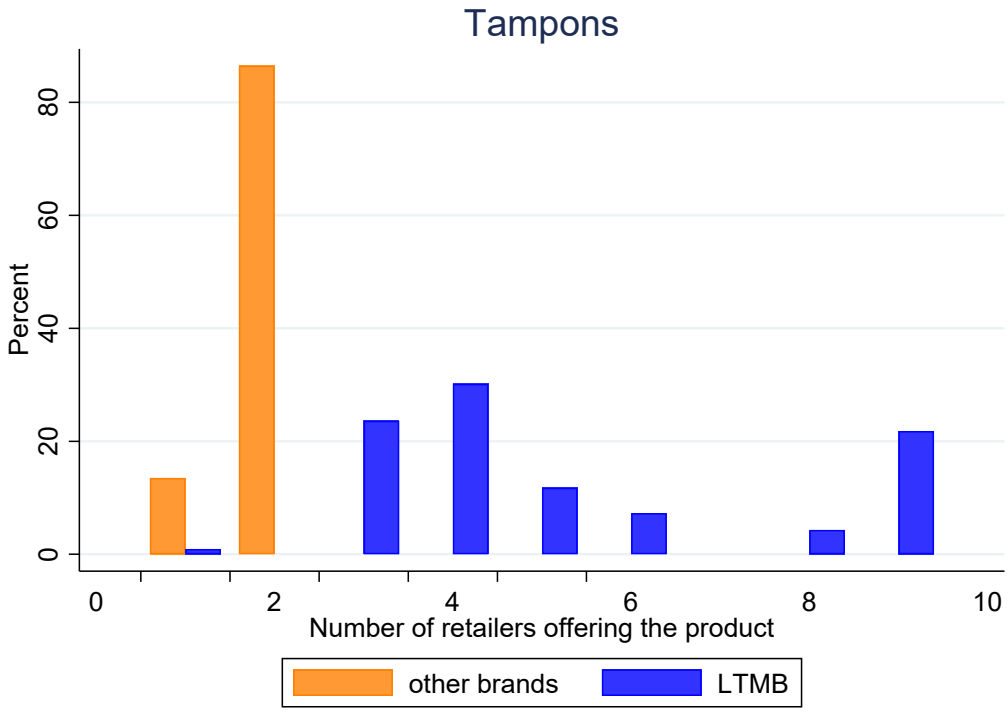

Figure 7: Share of LTMB and other brands by number of retailers offering the product

This difference is particularly striking for tampon products. We conjecture that there are fewer common competitor brands for tampons, while in the sanitary pad technology the difference between the leading manufacturer brand and other brands is smaller. Table 4 shows that, on average, there is more variety in the sanitary pad brands stocked than in the tampon brands. This strong competition in sanitary pads in terms of brand competition is a potential explanation for the observed differences in the VAT pass-through for different product types.

Table 4: Share of products offered at retailers differentiated by leading brand and other brands.

Retailer	Sanitary Pads		Tampons	
	LSMB	other brand	LTMB	other brand
A	100	0	100	0
B	100	0	100	0
C	95.21	4.79	100	0
D	100	0	100	0
E	60.00	40.00	89.47	10.53
F	100	0	100	0
G	89.58	10.42	94.25	5.75
H	89.36	10.64	93.18	6.82
I	75.00	25.00	65.22	34.78

4.2.3 Store-type Competition

Menstrual hygiene products belong to the drugstore category. Although both supermarkets and drugstores offer products from this category, it is commonly assumed that the latter offer a greater variety within the individual product groups. Figure 8 shows the VAT pass-through for drugstores and other stores. We find a significantly ($p = 0.01$, Wald Test) larger pass-through for drugstores. The estimated additional pass-through by drugstores is around one percentage point (see Table 5).

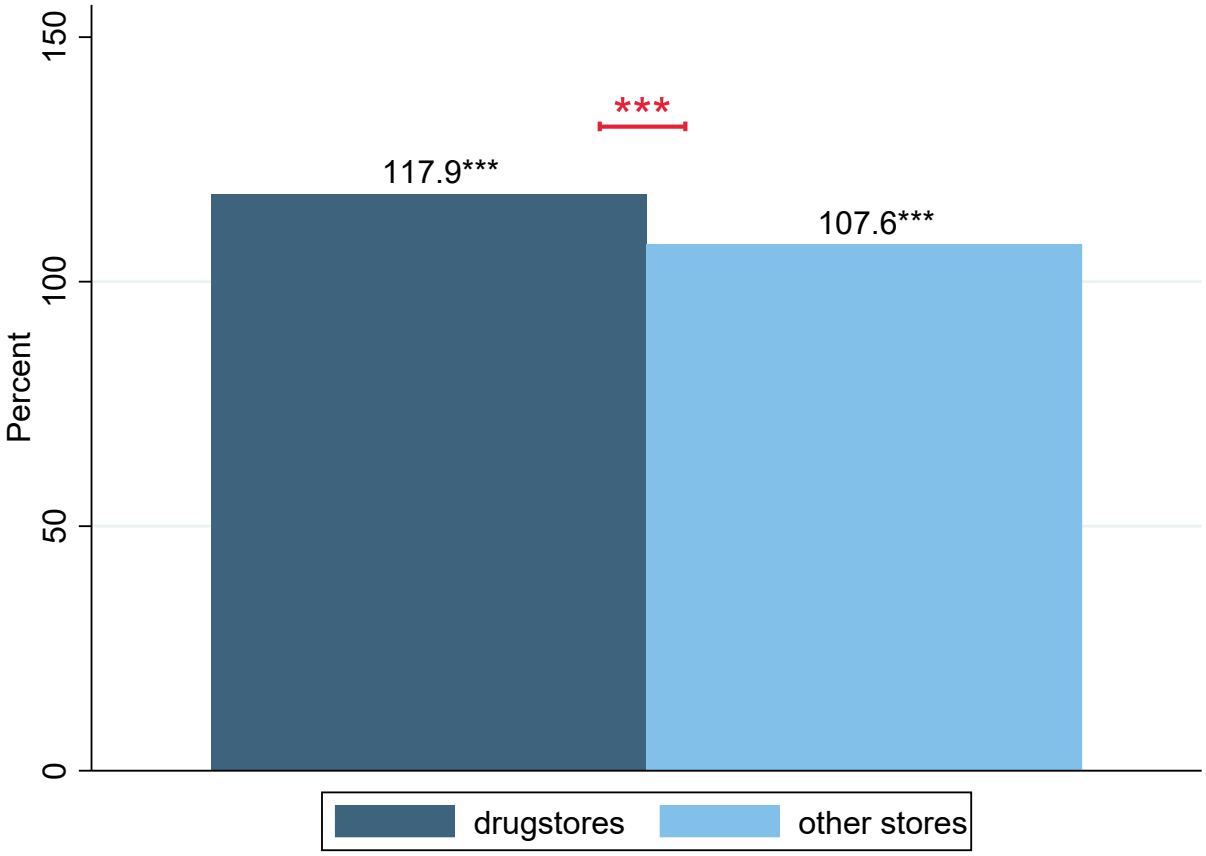

Figure 8: VAT pass-through in drugstores and other stores

Table 5: Relative price effects in drugstores and other stores

	Store-type
VAT Reduction	-0.115***
	(0.000522)
VAT Reduction ×	-0.0104***
Drugstore	(0.00155)
Constant	1.032***
	(0.0117)
Fixed Effects	✓
Observations	12930

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.2.4 Comprehensive Regression Analysis

We identify different effects which induce excess pass-through in the previous sections. One factor is the product type, as we identify significant differences between tampons and sanitary pads. Furthermore, competition has an effect on the pass-through rate which can be disentangled into a competition effect (namely the number of retailers) and a store-type effect.

Table 6 combines these effects in column (4). The price reduction for the tampon product type is around two percentage points lower than for sanitary pads. When the product is stocked in two or more retailers, this leads to around a 1.5 percentage point price reduction and, if the store is a drugstore, the price is reduced by around one additional percentage point. While these estimated effects are all highly significant ($p = 0.01$, Wald Test), we still find excess pass-through in the baseline (borderline significance, $p = 0.15$, Wald Test). We discuss this in section 5.

Table 6: Disentangled relative price effects

	(1) Base	(2) +Product Type	(3) +Competition	(4) +Drugstore
VAT Reduction	-0.121***	-0.129***	-0.113***	-0.110***
	(0.000912)	(0.00139)	(0.00253)	(0.00251)
VAT Reduction × type		0.0194***	0.0205***	0.0208***
		(0.00151)	(0.00151)	(0.00153)
VAT Reduction × competition			-0.0184***	-0.0153***
			(0.00262)	(0.00256)
VAT Reduction × drugstore				-0.00976***
				(0.00144)
Constant	1.032***	1.032***	1.032***	1.032***
	(0.0117)	(0.0117)	(0.0117)	(0.0117)
FE	✓	✓	✓	✓
R-square (within)	0.949	0.955	0.957	0.958
R-square (between)	.	0.075	0.110	0.121
R-square (overall)	0.025	0.034	0.038	0.040
Observations	12930	12930	12930	12930

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.3 Other Factors

4.3.1 Retailer-level analysis

Disaggregating the data by retailers, Table 7 shows that all retailers reduced their prices by at least the amount or even more than the VAT reduction would suggest. Retailer I reduced its gross prices by more than one percentage point more than most other competitors. Also, retailer G and E were above the average reduction in Table 1. In Appendix C.1 we deepen this retailer-level analysis further with respect to the two product groups as well as potential brand effects. We again identify differences between reductions for the two product groups, but not for all retailers.

Table 7: Relative price effects by retailer

	A	B	C	D	E	F	G	H	I
VAT Reduction	-0.114***	-0.114***	-0.115***	-0.116***	-0.123***	-0.115***	-0.131***	-0.117***	-0.134***
	(0.0027)	(0.0027)	(0.0007)	(0.0009)	(0.0047)	(0.0028)	(0.0028)	(0.0008)	(0.0069)
Constant	1.314***	1.314***	0.998***	1.299***	0.951***	1.306***	0.947***	1.027***	1.170***
	(0.0226)	(0.0226)	(0.0241)	(0.0075)	(0.0593)	(0.0230)	(0.0222)	(0.0242)	(0.0584)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	135	135	3930	1170	660	120	3465	2730	585

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.3.2 Size and package-size analysis

Sanitary pads and tampons are further differentiated by size and package size. For both technologies there is a so-called "normal" size which is very popular for both. The "normal" size is the most frequently offered type of tampon in our data. Among sanitary pads, those with "wings" are the most commonly offered types followed by "normal".

In Appendix C.2, Table 13, columns (2) and (3) show that the relative price reductions for the two sanitary pad types offered most in the data are smaller than the reduction at the aggregated level, but they exceed the benchmark of 10.084 percent. Columns (6) and (7) show the two most frequently offered combinations of size and package size for sanitary pads. With relative price reductions of 11.32

percent and 12.74 percent they are also significantly above the benchmark (for (6) $p = 0.01$ and for (7) $p = 0.05$, Wald Test). The results and signs in Table 14 indicate that the relative price reduction for products from the LSMB was smaller than for those from other brands.

For the tampon technology, tables 15 and 16 show a quite homogeneous price reduction for all types and also for the two most frequently offered combinations of size and package size. Only column (2) in Table 16 suggests that for the common tampon size "super" the relative price reduction in the data was with 9.52 percent below the benchmark.

5 Discussion

Standard theory with inelastic demand predicts a full pass-through of the VAT reduction in perfectly competitive markets. In our analysis we find a pass-through of even more than 100 percent for both the joint market for menstrual hygiene products and the separation into two product groups.

5.1 Excess Pass-Through

Figure 9 shows the changes in net prices over the observed time period. While the average net price change for tampon products before and after the VAT reduction is less than one euro cent, the difference between net prices for sanitary pads is larger at around four euro cent. The temporal net price drop corresponds to the observed price drop after the law that reduced the VAT for menstrual products had been passed but was not yet in effect.

This net price reduction displays the part of the observed excess pass-through which is borne by the retailers. We identify three potential explanations for the excess pass-through rate: First, rounding effects, and second, retailer competition, in combination with, third, particularly intense media attention to these prices.

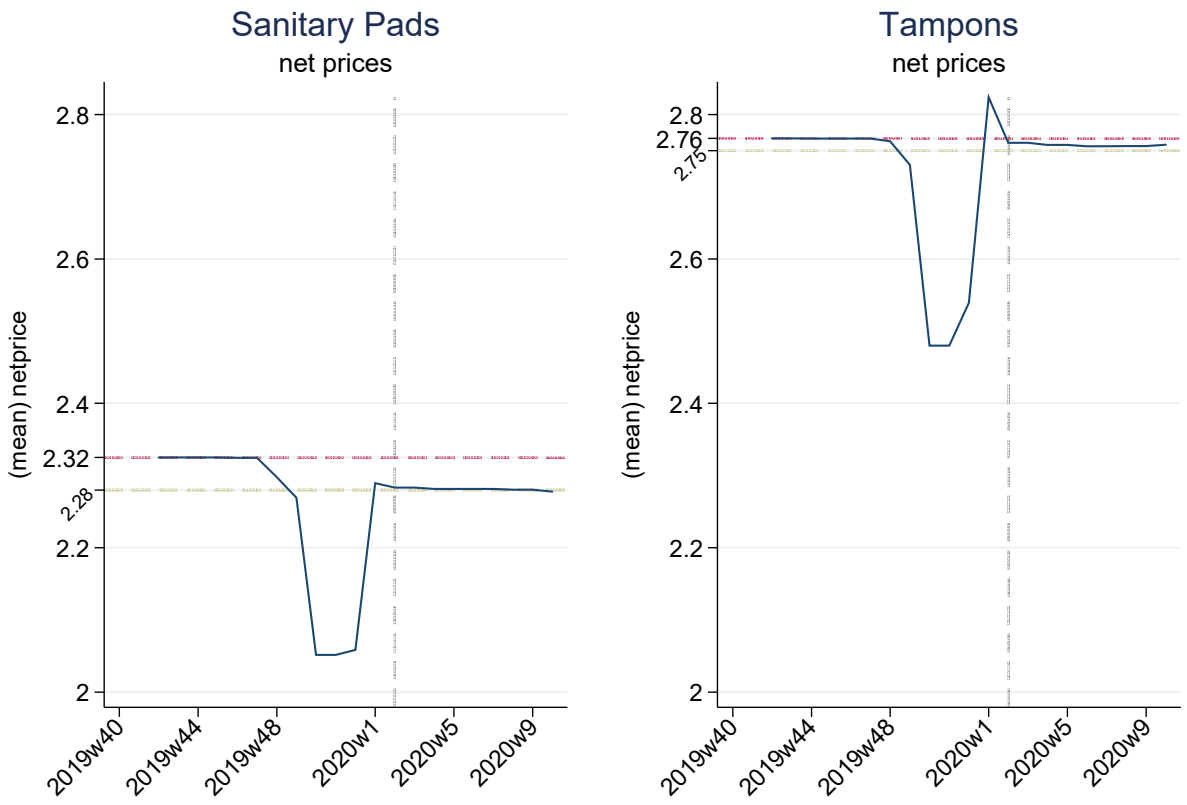

Figure 9: Net price evolution over time

5.2 Rounding Effects

Most retailers have a preference for prices to end with a 0, 5 or 9 in the second decimal and set consumer prices accordingly.[13] In our data we find this for more than 99 percent of all price observations. We also see that some retailers set all prices ending with one preferred second decimal while others mix between these preferred second decimals.

Before the VAT change, most gross prices were set such that they ended with these second decimals. With the VAT change, but assuming that retailers want to pass through at least 100 percent of the reduction, they might have to reduce their net prices in many cases to adjust the new calibration for the preferred second decimal. This rounding downwards effect might explain a systematic excess

[13]These preferences result from the so-called "pricing in the nine" phenomenon (see Nagle & Holden, 1987; Ginzberg, 1936). Effects of this pricing strategy have been studied e.g., in Schindler & Kibarian (1996) Schindler & Kirby (1997), and Stiving & Winer (1997). Basu (1997) provides an economic explanation for this pricing strategy.

pass-through of up to 1.5 – 2.0 percentage points more. For more details on the rounding-effects please refer to Appendix B.

5.3 Retailer Competition

In addition, competition among retailers may explain some part of the excess pass-through. In section 4.2 we identify differences in pass-through rates between those products that are only offered at one retailer and those being offered at more than one retailer. We conjecture that this difference is a result of competition. With competition, pass-through is larger than without.

We also identify that there is more intense competition among the products of the leading brand manufacturers, especially in the tampons segment. Figures 6 and 7 show that for both leading manufacturer brands there are core products offered by all nine retailers. The number of retailers offering the products from the leading brand manufacturers suggest that both brands may be products that must be stocked by the retailers, so-called "must-stock items".[14]

However, other manufacturer brands are much more rarely represented at the retailers. This is another difference between the two product groups. While for sanitary pads there are products from at least one other manufacturer that are offered in up to five retailers, as Figure 6 shows, no other manufacturer brand is similarly represented in the tampon segment, as Figure 7 illustrates.

That difference in relative market position may provide a plausible explanation for the observed VAT pass-through differences between the product groups. Also, the differences between the two product groups may originate from the differences in competition between the products in the segment as this competition between brands is larger for sanitary pads in comparison to tampons.

Furthermore, strong competition especially within the products from the leading manufacturer brands, may have led to the retailers taking this external shock as an

[14]These are products which consumers expect to find in the retail product range. An exclusion of "must-stock" items might negatively influence a retailer's business result. For more details, see Institut für Handelsforschung (2009).

opportunity to undercut others' prices. The more intense price variation, as seen in Figure 1, lasted for several weeks after the VAT reduction had been decided.

To fully understand why competition between retailers may have led to pass-through rates of more than 100 percent, it is important to understand the nature of competition between retailers. As consumers typically can only memorize a limited number or prices for a limited set of products, supermarkets and drugstores tend to compete especially on the prices that consumers pay the most attention to. These are typically fast-moving consumer goods that consumers purchase frequently such as milk, butter, coffee, sweets, and some other products that are purchased often.

As a consequence, supermarkets often only earn slim or even negative margins on these products, as they use these prices as marketing tool to lure customers into their stores. In turn, supermarkets make most of their profits on the goods that receive less attention by consumers and for which many consumers do not remember prices as well and do not compare prices as often. The tax cut on menstrual hygiene products, which was widely covered in the media, may have shifted consumers' attention to just these products, so that competition between supermarkets may also have shifted towards these particular products in consumers' basket of goods.

5.4 Media Coverage

The campaign mentioned at the beginning, which accompanied the petition, can be seen as a further factor that could have an impact on the pass-through of the tax. Media coverage in the form of press reports and advertisements creates pressure and expectations for the pass-through of the VAT cut, especially through the arguments of discrimination used to support the campaign.

Retailers actively promoting the VAT cut and the corresponding price reduction even before the change came into force has been anecdotally observed[15]. Around

[15]See Klug (2019). Similarly, promotion activities have been observed for other VAT cuts, see e.g., Crossley et al. (2009) who provide anecdotal evidence on active retailer promotion on a temporary VAT cut in UK.

the same time, news articles covering the VAT change were published in tabloids but also different international, national and regional newspapers.[16] Therefore, we assume media coverage as being a burning glass and a boost for the effects previously mentioned.

More precisely, the intense media coverage of this tax cut may have affected consumer attention, and thereby shifted competition between supermarkets toward tampons and sanitary pads. In addition, any media report that a retailer was passing through less than 100 percent could have resulted in very negative marketing, especially given the highly political campaign around the tax cut, which suggested that the previous VAT rate discriminated against women. Hence, to be on the safe side and avoid negative press coverage, retailers may have also implemented a slightly larger price cut than the VAT reduction would have implied.

6 Conclusion

In this paper we have studied the price effects caused by a VAT (value-added tax) reduction for menstrual hygiene products in Germany. Overall, we see more than complete pass-through of the tax reduction from retailers to final consumers. The average pass-through was close to two percentage points larger than the VAT reduction implies. Thus, the aim of reducing consumer prices for menstrual hygiene products seems to have been accomplished. Also, the perceived discrimination of menstruating women paying VAT for necessities which they have to use because of their gender is reduced by this tax policy.

Since the reduction of the VAT was more than predicted for all products, as the analysis shows, the remaining question is, what drives this over-fulfillment? One explanation is that this might result from rounding issues due to preferred prices ending with 0, 5 or 9 and that the direction of rounding was mainly downward. However, these rounding issues alone cannot explain the systematic

[16] See for example online sources from: RTL, Gala, The New York Times, The Washington Post, tagesschau, Handelsblatt, Augsburger Allgemeine, Mitteldeutsche Zeitung.

difference between the reductions within the sanitary pads and the tampons which we also identify.

Concerning competition effects, we see a large difference between pass-through rates with respect to competition at the product level. As the result without competition forms an upper boundary for the real value, competition leads to an at least 15 percentage-point higher relative price reduction. Therefore, competition effects can also explain some part of the excess price reduction that we observe.

Besides, differences between the competitive situation within the two product groups might be one possible explanation for the observed difference between sanitary pads and tampons. Since this is also driven by the demand side we cannot deepen this aspect and this could be subject to further research.

Also, we analyze the VAT reduction rates for different segmentations of the market. We separated the market by retailers. Besides, we also separated by leading manufacturer brand and others as well as by size or type within the product category. Overall, these analyses show a VAT reduction exceeding the benchmark in nearly all segmentations. They also support the observation of a systematic difference between the two product groups.

Since supermarkets and drugstores typically stock well more than 1000 products and consumers can only memorize and compare a small subset of prices, most consumers focus on only a few prices to choose their retailer. The high level of media coverage surrounding the tax cut may have shifted consumers' attention to tampons and sanitary pads, thereby intensifying retailer competition in this product segment. Consequently, retailers may have also been forced to reduce their margins on these products, as competition in this segment may have increased as a result of the intense public reporting on the tax cut.

Based on our data, we cannot make a qualitative statement about the effect of the high media coverage for this topic. However, the immediate price drop just after the policy change was finally decided, supports this hypothesis. This issue could play a more substantial role in further research.

A Detailed Chronology

The timeline in Table 8 highlights the important stages of the decision process towards the VAT reduction. Although the process that started with the online petition began well before the first draft, the relevant stages are within our observed time period. The dataset used in our analysis starts with WN 42 (10/14/2019) and therefore includes the week when the draft law was released. Also, the moment of the final vote in the German Bundestag in WN 45 (11/07/2019), the date when the legal process was approved in the Bundesrat on 11/29/2019 (Friday of WN 48 in 2019), and WN 1 in 2020 (01/01/2020), the date when the legislative amendment officially came into force, are within the observed time frame.

Table 8: Timeline from the petition to the passed law

In 2018	Start of the petition „Die Periode ist kein Luxus“ (“The period is not a luxury”) on the platform change.org.*
9^{th} *February* 2019	Date of submission of the petition to reduce the VAT for menstrual products in the Bundestag.
8^{th} *March* 2019	The tax reduction topic is in media and a politician from the conservative ruling party speaks positively about a tax reduction demand.
16^{th} *April* 2019	The guerilla marketing activity named „The Tampon Book“ was launched and the campaign was attracting more and more politicians to its side.
27^{th} *May* 2019	The petition in the Bundestag reaches the quorum of at least 50,000 signatures.
3^{rd} *September* 2019	A federal state requests the Bundesrat to deal with the issue at the earliest possible date.
4^{th} *October* 2019	The Minister of Finance announces intention to reduce the tax as of 1 January 2020.
22^{nd} *October* 2019	The draft law on the tax reduction of menstrual products is fixed.
7^{th} *November* 2019	The Bundestag approves the draft law.
29^{th} *November* 2019	The Bundesrat approves the change in the tax law as proposed by the Bundestag before.
1^{st} *January* 2020	Menstrual hygiene products are taxed with 7 percent instead of 19 percent VAT.

* Non-binding for the parliament

B Rounding Effects

Some retailers prefer prices to end with a 0 and 5 or 9 in the second decimal. In our data we observe this for more than 99 percent of all price observations. We also see that some retailers set all prices ending with one preferred second decimal while others mix between these preferred second decimals.

The prices in our data prior to the VAT reduction on menstrual products was passed ended with a 5 in 85.85 percent of the observations and a 9 in 14.15 percent. After the policy, 75.12 percent ended with a 5, 13.10 percent with a 9, 11.65 percent with a 0, and in 0.13 percent of the observations the second decimal is 8.

Before the VAT change, most gross prices were calibrated to these second decimals. If the VAT changes, but retailers want to pass through at least 100 percent of the reduction, they might have to reduce their net prices in many cases to adjust the new calibration for the preferred second decimal. The maximal difference between the actual and rounded gross price is 9 euro cents.

As an example: Assume a gross price of €9.99 including a VAT of 19 percent. The corresponding net price is €8.3950 (rounded value). If there was a new reduced VAT of 7 percent, the new gross price would be €8.98. If this gross price was calibrated downwards to a 9 in the second decimal, the new gross price would be €8.89. But now the corresponding net price also changes to €8.3084, which is an absolute reduction of the net prices by 8.66 euro cents. The gross price in this example was reduced by €1.10 which is a relative reduction of 11.01 percent and not 10.084 percent.

If we assume the differences between the actual and rounded gross prices are uniformly distributed between 0 and 9 euro cents, the average additional reduction of the new gross price after the VAT reduction is 4.5 euro cents. The average price of sanitary pads in our data is €2.56 such that a reduction of 4.5 euro cents means a relative reduction of 1.98 percent. The average price of tampons in our data is €3.09. For tampons the reduction of 4.5 euro cents means a relative reduction of

1.59 percent. Therefore, depending on the technology, a price reduction of up to 1.5 – 2.0 percentage points more than the expected 10.084 percent reduction could be explained by rounding effects.

C Supplementary Regression Results

C.1 Retailer

Differentiating the retailer-level view further by product type, reveals again an imbalance. There are some differences in the effect sizes for the more popular-type tampon in comparison to sanitary pads. Comparing Table 9 and Table 11 shows that only Retailer C had a quite uniform price reduction for both product types. This reduction of around 10.82 percent also significantly exceeded the benchmark of 10.084 percent. Retailer I reduced the prices for both product types by more than the benchmark, having the highest significant reduction in the sanitary pads segment with 14.42 percent. In the tampons segment, the reductions from retailers E and G are below the benchmark, so their pass-through does not significantly exceed the 100 percent pass-through.

Table 12 shows that Retailer E reduced the tampon prices, on average, by 5.38 percent if the product was not from the leading tampon manufacturer brand. Whereas the prices of products from the leading tampon manufacturer brand were reduced by 10.21 percent by Retailer E, which is slightly above the benchmark of 10.084 percent.Table 10 shows the effect in the sanitary pads segment differentiating for the leading sanitary pad manufacturer brand. Whereas Retailer G reduced the prices for the products of the leading sanitary pad manufacturer brand even more, Retailer H chose a different path and reduced the products of the leading sanitary pad manufacturer brand less than the remaining manufacturer brands in stock.

Altogether, tables 9 to 12 show that the relative price reduction in the sanitary pads segment exceeded the reduction for tampon products among all retailers in this analysis by up to 3.5 percentage points (Retailer G). While the relative price reduction for the leading manufacturer brand in the sanitary pads segment was less than the overall reduction in this segment, the results reveal a different approach in the tampons segment where the relative price reduction of the leading tampon manufacturer brand products was higher than for other manufacturer brands.

Table 9: Relative price effects by retailer for sanitary pads

	A	B	C	D	E	F	G	H	I
VAT Reduction	-0.123	-0.123	-0.115***	-0.123	-0.138***	-0.123	-0.146***	-0.125***	-0.156***
	(0)	(0)	(0.000971)	(0)	(0.00532)	(0)	(0.00377)	(0.000760)	(0.0112)
Constant	1.238	1.238	0.957***	1.238	0.783***	1.238	0.851***	0.964***	1.023***
	(0)	(0)	(0.0336)	(0)	(0.0760)	(0)	(0.0254)	(0.0341)	(0.0895)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	60	60	2505	645	375	60	2160	1410	240

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Relative price effects by retailer for sanitary pads | LSMB

	A	B	C	D	E	F	G	H	I
VAT Reduction	-0.123	-0.123	-0.124***	-0.123	-0.137***	-0.123	-0.119***	-0.140***	-0.139***
	(0)	(0)	(0.00150)	(0)	(0.00132)	(0)	(0.00570)	(0.00436)	(0.0141)
LSMB ×			0.0102***		-0.00216		-0.0295***	0.0166***	-0.0224
VAT Reduction			(0.00178)		(0.00900)		(0.00701)	(0.00438)	(0.0199)
Constant	1.238	1.238	0.957***	1.238	0.783***	1.238	0.851***	0.964***	1.023***
	(0)	(0)	(0.0335)	(0)	(0.0760)	(0)	(0.0254)	(0.0341)	(0.0895)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	60	60	2505	645	375	60	2160	1410	240

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Relative price effects by retailer for tampons

	A	B	C	D	E	F	G	H	I
VAT Reduction	-0.107	-0.107	-0.115***	-0.107	-0.102***	-0.107	-0.106***	-0.108***	-0.119***
	(0)	(0)	(0.000637)	(0)	(0.00508)	(0)	(0.000444)	(0.000558)	(0.00644)
Constant	1.374	1.374	1.070***	1.374	1.172***	1.374	1.106***	1.094***	1.272***
	(0)	(0)	(0.0317)	(0)	(0.0636)	(0)	(0.0372)	(0.0378)	(0.0631)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	75	75	1425	525	285	60	1305	1320	345

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Relative price effects by retailer for tampons | LSMB

	A	B	C	D	E	F	G	H	I
VAT Reduction	-0.107	-0.107	-0.115***	-0.107	-0.0553***	-0.107	-0.0950***	-0.113***	-0.114***
	(0)	(0)	(0.000637)	(0)	(0.00607)	(0)	(0.00647)	(0.00349)	(0.00252)
LTMB ×					-0.0524***		-0.0113	0.00520	-0.00825
VAT Reduction					(0.00704)		(0.00648)	(0.00354)	(0.0102)
Constant	1.374	1.374	1.070***	1.374	1.172***	1.374	1.106***	1.094***	1.272***
	(0)	(0)	(0.0317)	(0)	(0.0633)	(0)	(0.0372)	(0.0378)	(0.0631)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	75	75	1425	525	285	60	1305	1320	345

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.2 Size & Packsize

Table 13 presents the relative price effects for different product sizes as well as the effects for the two most frequent size and packsize combinations. Although there are differences across the sizes, they all significantly exceed the benchmark ($p = 0.01$, Wald Test). Table 14 includes a dummy variable for the LSMB.

Table 13: Relative price effects by size (and packsize) for sanitary pads | including the two most frequent combinations of size#packsize

	all types	wings	normal	long	night	wings#18	normal#14
VAT Reduction	-0.129***	-0.126***	-0.126***	-0.135***	-0.135***	-0.120***	-0.135***
	(0.00145)	(0.00248)	(0.00222)	(0.00359)	(0.00372)	(0.00107)	(0.00615)
Constant	0.952***	0.905***	0.950***	0.971***	1.015***	1.238	0.570***
	(0.0166)	(0.0291)	(0.0375)	(0.0335)	(0.0357)	(0)	(0.00711)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	7515	2355	1965	1455	1335	495	435

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Relative price effects by size for sanitary pads | LSMB

	wings	normal	long	night
VAT Reduction	-0.134	-0.128***	-0.137***	-0.133***
	(0)	(0.00393)	(0.00342)	(0.00654)
LSMB ×	0.00844***	0.00250	0.00175	-0.00170
VAT Reduction	(0.00246)	(0.00451)	(0.00513)	(0.00768)
Constant	0.905***	0.950***	0.971***	1.015***
	(0.0294)	(0.0375)	(0.0336)	(0.0357)
Fixed Effects	✓	✓	✓	✓
Observations	2355	1965	1455	1335

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The relative price effects for tampon products are presented in Table 15. The price reductions do not differ significantly across sizes. The most frequent combinations of size and packsize are also aligned. Table 16 includes a dummy variable for the LTMB.

Table 15: Relative price effects by size (and packsize) for tampons | including the two most frequent combination of size#packsize

	all types	normal	super	superplus	mini	normal#16	super#16
VAT Reduction	-0.110***	-0.110***	-0.110***	-0.109***	-0.108***	-0.110***	-0.110***
	(0.000613)	(0.00119)	(0.00149)	(0.00104)	(0.00106)	(0.00231)	(0.00288)
Constant	1.144***	1.050***	1.062***	1.306***	1.068***	0.737***	0.744***
	(0.0172)	(0.0326)	(0.0355)	(0.0174)	(0.0566)	(0.0212)	(0.0250)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	5415	1665	1395	1005	660	855	690

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: Relative Price Effects by size for tampons | LTMB

	normal	super	superplus	mini
VAT Reduction	-0.104***	-0.0952***	-0.109***	-0.111***
	(0.00698)	(0.0103)	(0.00104)	(0.00586)
LTMB ×	-0.00641	-0.0154		0.00256
VAT Reduction	(0.00709)	(0.0105)		(0.00592)
Constant	1.050***	1.062***	1.306***	1.068***
	(0.0326)	(0.0352)	(0.0174)	(0.0566)
Fixed Effects	✓	✓	✓	✓
Observations	1665	1395	1005	660

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.3 Competition

Table 17 and Figure 10 present the results when we take the number of retailers (indicated by #) stocking a same given product into account. Because the dataset does not comprise the complete supply side, this number has to be interpreted as a proxy for the true number of retailers.

Table 17: Relative price effects by number of retailers offering the product

	#1	#2	#3	#4	#5	#6	#8⋆	#9
VAT Reduction	-0.107***	-0.122***	-0.129***	-0.118***	-0.128***	-0.110***	-0.109***	-0.115***
	(0.00234)	(0.00151)	(0.00252)	(0.000930)	(0.00440)	(0.00265)	(0.00170)	(0.000951)
Constant	1.218***	0.768***	0.748***	1.243***	0.932***	1.340***	1.374	1.306***
	(0.0480)	(0.0323)	(0.0176)	(0.0107)	(0.0522)	(0.0122)	(0)	(0.00797)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1110	1770	3375	4140	975	360	120	1080

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

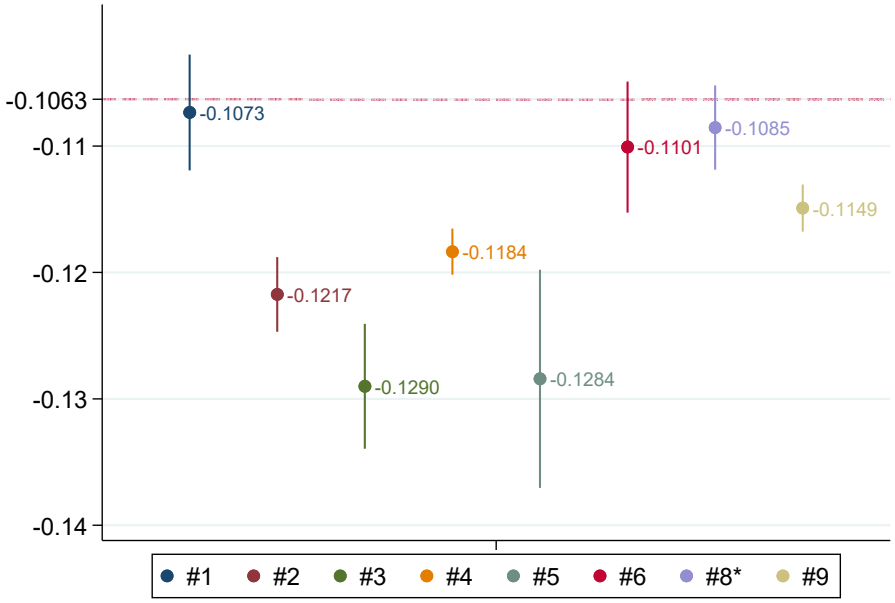

Figure 10: Relative price effects by number of retailers offering the product

The first column in Table 17 shows the average relative price reduction for products offered at just one retailer in the dataset. The relative price reduction of 10.73 percent is not significantly different from the benchmark of 10.084 percent.[17] The other columns of Table 17 show that if there is at least one competitor also stocking the same product, the VAT reduction is stronger. The pattern of coefficients shown in Figure 10 shows no strict relationship between a growing number of retailers offering a product and a higher price reduction. A potential U-shaped relationship is not clearly identifiable.

However, since not all retailers are included in our data, some of the products which are stocked at just one retailer here, might actually be offered at more than one in the whole market. As a result, the estimate when just one retailer offers a product can be interpreted as an upper boundary of the relative price effect. We therefore observe an upward bias in our estimate for one retailer. Accordingly, the real difference between one and more than one retailer stocking a product must be even larger than our results suggest.

Table 18 presents the relative price effects for different numbers of retailers offering the product with a type dummy variable. The negative sign of the type coefficients

[17] The benchmark of a 10.084 percent price reduction corresponds to a regression coefficient of -0.1063.

for two or more retailers strengthens the finding of stronger competition effects for sanitary pads from section 4.2.1.

Table 18: Relative price effects by number of retailers offering the product with product group distinction

	#1	#2	#3	#4	#5	#6	#8⋆	#9
VAT Reduction	-0.109***	-0.124***	-0.151***	-0.123***	-0.146***	-0.121***	-0.109***	-0.121***
	(0.00281)	(0.00162)	(0.00442)	(0.00130)	(0.00773)	(0.00232)	(0.00170)	(0.000848)
type ×	-0.00815	-0.0138***	-0.0428***	-0.0114***	-0.0325***	-0.0143***		-0.0131***
VAT Reduction	(0.00459)	(0.00400)	(0.00445)	(0.00174)	(0.00845)	(0.00376)		(0.00114)
Constant	1.220***	0.770***	0.770***	1.248***	0.949***	1.351***	1.374	1.313***
	(0.0479)	(0.0326)	(0.0186)	(0.0107)	(0.0524)	(0.0137)	(0)	(0.00880)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1110	1770	3375	4140	975	360	120	1080

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

⋆ tampons only

type dummy = 1 for tampons

C.3.1 Sanitary Pads

Table 19 and Figure 11 show the average relative price reduction for sanitary pad products offered depending on the number of retailers stocking the same product. The indicated price reductions exceed the benchmark in all cases considered except the first column, when only one retailer offers the product ($p = 0.2617$, Wald Test). The difference in reduction between this and the other columns is more than one percentage point. Table 20 includes the LSMB dummy variable.

Table 19: Relative price effects by number of retailers offering sanitary pads (#x) shows the number of retailers stocking the product

	#1	#2	#3	#4	#5	#6	#9
VAT Reduction	-0.109***	-0.124***	-0.151***	-0.123***	-0.146***	-0.121***	-0.121***
	(0.00279)	(0.00159)	(0.00457)	(0.00128)	(0.00813)	(0.00222)	(0.000877)
Constant	1.248***	0.678***	0.634***	1.200***	0.734***	1.238	1.238
	(0.0626)	(0.0247)	(0.0124)	(0.0104)	(0.0877)	(0)	(0)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	825	1530	1620	2460	450	90	540

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

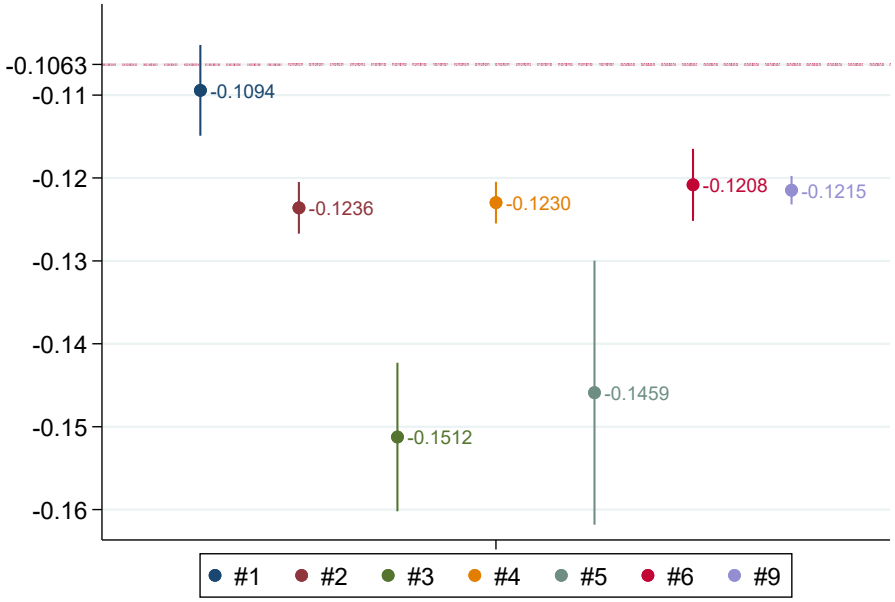

Figure 11: Relative price effects by number of retailers offering the product | Sanitary pads

Table 20: Relative price effects by number of retailers offering sanitary pads | LSMB (#x) shows the number of retailers stocking the product

	#1	#2	#3	#4	#5	#6	#9
VAT Reduction	-0.118***	-0.135***	-0.135***	-0.137***	-0.139***	-0.121***	-0.121***
	(0.00486)	(0.0118)	(0.00276)	(0.00337)	(0.00403)	(0.00222)	(0.000877)
LSMB ×	-0.0115	-0.0123	0.0178**	-0.0151***	0.00887		
VAT Reduction	(0.00602)	(0.0119)	(0.00591)	(0.00354)	(0.0103)		
Constant	1.256***	0.689***	0.618***	1.215***	0.726***	1.238	1.238
	(0.0620)	(0.0270)	(0.0122)	(0.0114)	(0.0905)	(0)	(0)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	825	1530	1620	2460	450	90	540

Bootstrap standard errors in parentheses.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C.3.2 Tampons

Similar to the previously mentioned sanitary pads, Table 21 and Figure 12 show the relative price effects for the tampon technology differentiated by the number of retailers stocking the same product. Also for the tampon technology, the relative price reduction is larger with competition. However, there seems to be no strict relation between the number of retailers stocking a product and the size of the reduction. For tampon products which are stocked only from one retailer the price

reduction of 9.63 percent is below the benchmark from the VAT reduction. Table 22 includes the LTMB dummy variable.

Table 21: Relative price effects by number of retailers offering tampons (#x) shows the number of retailers stocking the product

	#1	#2	#3	#4	#5	#6	#8⋆	#9
VAT Reduction	-0.101***	-0.110***	-0.108***	-0.112***	-0.113***	-0.106***	-0.109***	-0.108***
	(0.00365)	(0.00344)	(0.000358)	(0.00112)	(0.00332)	(0.00289)	(0.00170)	(0.000726)
Constant	1.133***	1.346***	0.854***	1.306***	1.102***	1.374	1.374	1.374
	(0.0472)	(0.0518)	(0.0277)	(0.0186)	(0.0535)	(0)	(0)	(0)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	285	240	1755	1680	525	270	120	540

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

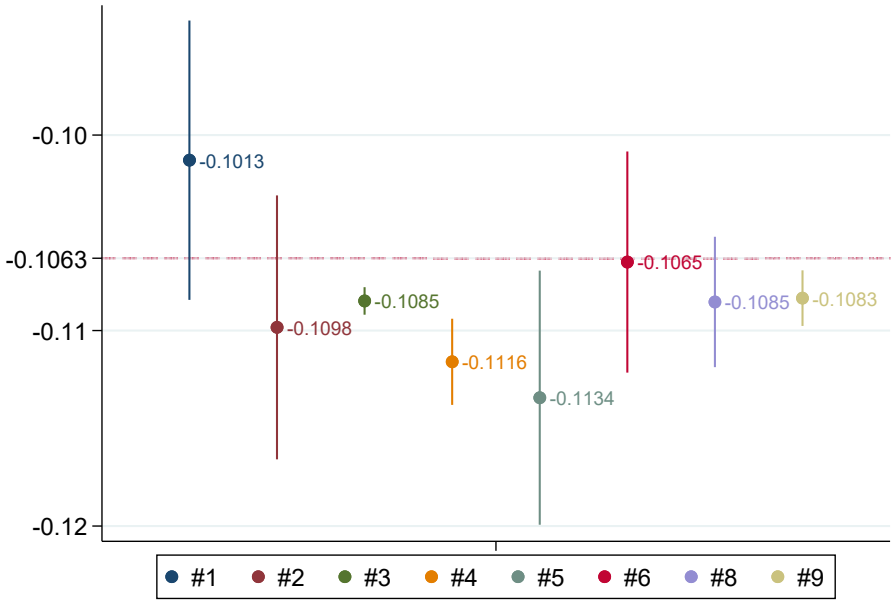

Figure 12: Relative price effects by number of retailers offering the product | Tampons

Table 22: Relative price effects by number of retailers offering tampons | LTMB (#x) shows the number of retailers stocking the product

	#1	#2	#3	#4	#5	#6	#8⋆	#9
VAT Reduction	-0.0834***	-0.110***	-0.108***	-0.112***	-0.113***	-0.106***	-0.109***	-0.108***
	(0.0106)	(0.00344)	(0.000358)	(0.00112)	(0.00332)	(0.00289)	(0.00170)	(0.000726)
LTMB × VAT Reduction	0.0242*							
	(0.0106)							
Constant	1.115***	1.346***	0.854***	1.306***	1.102***	1.374	1.374	1.374
	(0.0535)	(0.0518)	(0.0277)	(0.0186)	(0.0535)	(0)	(0)	(0)
Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	285	240	1755	1680	525	270	120	540

Bootstrap standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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