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## How German Online Retailers Price Foods: An Empirical Analysis for Chocolate Products<sup>\*</sup>

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### ABSTRACT

Despite the increasing importance of online grocery retailing, little is known about price dispersion across online providers, the relation between online and offline prices as well as the frequency of price adjustments. We employ means of descriptive and inductive statistics as well as panel econometrics to address these issues for German online food retailers. Daily online prices for twelve chocolate products charged by eight pure online and multichannel retailers and collected over three months are investigated. Information economics suggests that a maturing online market will call forth more price homogeneity online due to lower search costs by consumers as well as more flexible prices due to lower costs of price adjustments by retailers. Our results suggest, however, that neither homogenous prices nor frequent price adjustments do occur on the German online chocolate market.

*Keywords: Online pricing; food retailing; Germany; chocolate; pure online traders; multichannel traders*

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## 1 Introduction

Online retailing in Germany has been developing rapidly in recent years: in such segments as technical products and media or sports and leisure, online retailing accounts for about twenty percent of revenues. Food retailing is an online latecomer and its share in e-commerce is still modest, with only about one percent of the revenues in retailing being generated online. Yet, as food expenditures account for the largest share of consumers day-to-day purchases, online grocery retailing generates over 2.5 billion Euro of retailers' revenue already (DOPLBAUER 2015). This makes groceries an important part of the expanding digitalization of retailing. The role of online channels in food retailing is expected to increase substantially in the nearest future: pure online retailers and online sales by multichannel grocery retailers shall cover about 30 % of the food market by 2020 (ERNST & YOUNG 2014).

Major food retailers in Germany have already realized the perspectives of using both online and offline channels to better address their customers. Rewe and Edeka were among the first stores to open up their online platforms. And although they had an advantage of being known to their customers and already had a loyal clientele, they have to compete in the internet market with big international players such as Amazon, with which many customers have been already familiar from non-food online shopping (FITTKAU & MAAß 2014). This competitive situation makes the question of pricing online and offline a challenging task.

Information economics suggests that as the online market matures, search costs of consumers will substantially decline due to drastically reduced information asymmetry. Furthermore, competitive pressure – also due to low entry costs – will drive online retailers to a situation close to perfectly competitive markets. This should lead to identical prices for homogeneous goods across retailers and reduce or eliminate price dispersion online (BAKOS 1997).

On the other hand, various empirical studies for non-food products arrive at a very mixed evidence on price relations between online and offline. For instance, LEE et al. (1999) and EREVELLES et al. (2001) find that prices online are higher than offline, while BAILEY (1998) and ANCARANI (2002) suggest the reverse and CLAY et al. (2002) conclude that prices online and offline are on average the same if shipping costs are neglected. High price dispersion, however, seems to be a very robust finding for online markets (see e.g. PAN et al. 2004 for an overview), which questions information efficiency and its consequences for online prices predicted by the classical theory of information economics.

Online retailing will enjoy lower menu costs of price adjustments and less service and consultation costs, which are widespread in conventional markets for e.g. electronic products (TANG and XING 2001). Some studies suggest, however, that nonprice factors related to online retailing might be more important to consumers and may make them less price-sensitive (DEGERATU ET AL., 2000, ANCARANI 2002). This could give retailers the possibility to differentiate between groups of consumers (BAYLIS and PERLOFF 2002) and engage in a wide range of pricing strategies (ANCARANI 2002). While contradictory findings emerge from empirical studies on online pricing in the nonfood sector, even less is known about pricing in online grocery retailing.

This paper fills this gap in the literature by analyzing price development and dispersion in German online food retailing using chocolate products as an example. Chocolate and confectionery belong to those products that are bought online most often (FITTKAU & MAAß 2014, ERNST & YOUNG 2014). To fulfil this task we collect price data for twelve chocolate products across eight online players, including four pure online retailers and four multichannel retailers, over a three-month period.

The remainder of the paper is structured as follows. In Section 2, the data are introduced and descriptive statistics provided. Moreover, hypotheses regarding price-setting in online grocery retailing are formulated and inductive statistics are applied to test those hypotheses. In Section 3, a multivariate analysis of factors determining online chocolate prices is provided. Results are summarized and conclusions are drawn in Section 4.

## 2 Data and statistical analysis

### 2.1 The sample

Our sample comprises price data on twelve chocolate products collected daily over three months (August 26 – November 26, 2013) from eight major online sweets suppliers, including four pure online players (Lebensmittel.de, Foodstore, World of Sweets and suesswarenhaus24) and four multichannel retailers (REWE Online, real,- Drive, EDEKA24 and myTime.de).

REWE was the first major food retailer who started an online delivery service for groceries in 2011. Its online store offers a full range of products from all product categories (LODERHOSE 2011; REWE.DE 2016). Real,- Drive allows goods to be ordered online and picked up in a stationary market by the customers or be delivered to their homes (REAL-DRIVE.DE 2016). The product range of EDEKA24 is considerably smaller than in its stationary stores (EDEKA24.DE 2016). The online shop myTime.de has been operating since 2012 and is part of the trading group Bunting. Differently from Edeka, the online assortment of Bunting is much larger than offline and offers more high-quality products (BUENTING.DE, 2016). Lebensmittel.de has operated since 2009 and provides now more than 24,000 products (RODE 2012; LEBENSMITTEL.DE 2016). Foodstore, World of Sweets and suesswarenhaus24 use the Amazon marketplace as a sales platform for their products. Their assortment is significantly smaller compared to all the other suppliers in our sample.

Table 1 provides an overview of the products in the sample (all national brand products, 100 gram bars) and some descriptive statistics on their prices.

**Table 1.**  
Descriptive Statistics for Prices of Chocolate Products (Euro)

Chocolate Products	Mean	Median	Max.	Min.	Std. Dev.	Obs.
Milka Alpenmilch	0.99	0.95	1.22	0.59	0.14	507
Milka Alpenmilchcrème	1.06	0.95	1.35	0.59	0.18	591
Milka Noisette	1.05	0.95	1.35	0.59	0.18	676
Ritter Sport Edel-Vollmilch	1.05	1.09	1.40	0.65	0.21	543
Ritter Sport Nugat	1.06	1.09	1.43	0.65	0.23	596
Alpia Alpenmilch	0.69	0.69	0.89	0.39	0.14	432
Alpia Edel-Nougat	0.60	0.65	0.69	0.39	0.10	279
Kinder Schokolade	1.16	1.19	1.39	0.95	0.16	629
Yogurette	1.06	0.99	1.19	0.99	0.08	495
Toblerone	1.40	1.29	1.89	1.11	0.27	611
Sarotti Schwarze Herren Edelbitter	1.36	1.19	1.99	0.99	0.35	460
Lindt Excellence 70 % mild	2.02	1.95	2.18	1.95	0.11	274

Source: Own computations.

## 2.2 Statistical Analysis of Online Prices: Price Level, Dispersion and Flexibility

In the following, we use means of descriptive and inductive statistics to address four questions concerning the level of online prices:

- (i) Are online prices for homogeneous goods identical across retailers?
- (ii) Do pure online traders price chocolate differently from multichannel retailers?
- (iii) Do chocolate prices of multichannel retailers differ online and offline?<sup>2</sup>
- (iv) Are online prices flexible or rigid over the sample period?

### 2.2.1 Are Online Prices Identical for Homogeneous Goods?

As search costs in online markets are lower compared to brick-and-mortar stores (BAKOS 1997), the online market for chocolate bars might be close to a perfectly competitive market. In this case, if all online providers are perceived as homogeneous by consumers, arbitrage would assure that an identical price would hold for all individual products across online stores. Therefore, we formulate the first hypothesis as follows:

**Hypothesis 1:** *Prices for homogeneous chocolate products are identical across online providers, since prices can be compared with very low search costs on the internet.*

In order to test this hypothesis, we utilized descriptive and inductive statistics to compare price levels of the various suppliers and to measure price dispersion across online producers. As collected prices for the individual products were not normally distributed, we use the median  $\tilde{x}$  to compare price levels of different suppliers (Table 2). As prices vary substantially across suppliers, Table 2 additionally reports the coefficient of variation for each product (CV).

**Table 2.**  
Comparison of Price Levels of Chocolate Bars across Online Retailers (Euro)

Chocolate Products	REWE Online	real-Drive	EDEKA 24	myTime.de	Lebensmittel.de	Food-store	World of Sweets	suess-waren-haus24	CV (%)
Milka Alpenmilch	0.95 <sup>a</sup>	0.89 <sup>b</sup>	0.95 <sup>a</sup>	0.89 <sup>c</sup>	n.a.	1.19 <sup>d</sup>	1.22 <sup>e</sup>	n.a.	14.14
Milka Alpenmilchcrème	0.95 <sup>a</sup>	0.89 <sup>b</sup>	0.95 <sup>a</sup>	0.89 <sup>c</sup>	1.13 <sup>d</sup>	1.19 <sup>e</sup>	1.22 <sup>f</sup>	1.35 <sup>g</sup>	16.98
Milka Noisette	0.95 <sup>a</sup>	0.89 <sup>b</sup>	0.95 <sup>a</sup>	0.89 <sup>c</sup>	1.03 <sup>d</sup>	1.19 <sup>e</sup>	1.22 <sup>f</sup>	1.35 <sup>g</sup>	17.14
Ritter Sport Edel-Vollmilch	0.89 <sup>a</sup>	n.a.	1.09 <sup>b</sup>	0.75 <sup>c</sup>	1.39 <sup>d</sup>	1.08 <sup>e</sup>	1.11 <sup>f</sup>	1.40 <sup>g</sup>	20.00
Ritter Sport Nugat	0.89 <sup>a</sup>	0.85 <sup>b</sup>	1.09 <sup>c</sup>	0.75 <sup>d</sup>	1.43 <sup>e</sup>	1.19 <sup>f</sup>	1.11 <sup>g</sup>	1.40 <sup>h</sup>	21.70
Alpia Alpenmilch	0.65 <sup>a</sup>	0.49 <sup>b</sup>	n.a.	0.69 <sup>c</sup>	n.a.	0.89 <sup>d</sup>	0.77 <sup>e</sup>	n.a.	20.29
Alpia Edel-Nougat	0.65 <sup>a</sup>	0.49 <sup>b</sup>	n.a.	0.69 <sup>c</sup>	n.a.	n.a.	n.a.	n.a.	16.67
Kinder Schokolade	0.99 <sup>a</sup>	0.95 <sup>b</sup>	1.19 <sup>c</sup>	0.99 <sup>a</sup>	n.a.	1.29 <sup>d</sup>	1.29 <sup>d</sup>	1.39 <sup>e</sup>	13.79
Yogurette	0.99 <sup>a</sup>	1.09 <sup>b</sup>	0.99 <sup>a</sup>	0.99 <sup>a</sup>	1.17 <sup>c</sup>	1.19 <sup>d</sup>	n.a.	n.a.	7.55
Toblerone	1.29 <sup>a</sup>	1.19 <sup>b</sup>	1.39 <sup>c</sup>	1.19 <sup>b</sup>	1.56 <sup>d</sup>	1.69 <sup>e</sup>	1.11 <sup>f</sup>	1.89 <sup>g</sup>	19.29
Sarotti Schwarze Herren Edelbitter	0.99 <sup>a</sup>	n.a.	1.19 <sup>b</sup>	1.19 <sup>b</sup>	n.a.	n.a.	1.44 <sup>c</sup>	1.99 <sup>d</sup>	25.74
Lindt Excellence 70 % mild	1.95 <sup>a</sup>	n.a.	n.a.	1.95 <sup>a</sup>	n.a.	n.a.	2.18 <sup>b</sup>	n.a.	5.45

Notes: This table shows the median in Euros. n.a.: Not calculable due to missing data. <sup>a, b, c, d, e, f, g, h</sup> Median values with the same superscript index in one row are not significantly different from each other.

Source: Own computations.

<sup>2</sup> In order to undertake this comparison, we additionally collected price data in three conventional stores of Edeka, Real and Rewe on November 25, 2013, in Giessen (Germany).

Table 2 indicates that prices for homogenous chocolate products often differ across online retailers and that price dispersion is relatively high, especially for some chocolate sorts (e.g. Sarotti Schwarze Herren Edelbitter with a coefficient of variation of almost 26 percent). Even though for some products such as Lindt or Yogurette dispersion across retailers is smaller, the average value of the coefficient of variation in our sample is about 16.6 %.

To compare whether the prices of chocolate bars significantly differ across individual retailers during the period of analysis, a number of non-parametric tests were used. The Kruskal-Wallis test suggests that the prices of individual suppliers are significantly different from each other ( $p\text{-value } (0.00) < \alpha (0.05)$ ). Therefore, the suppliers were analyzed in pair-by-pair comparisons. The results of the Mann-Whitney tests can be seen based on the superscripts in Table 2. There are median values which are significantly different from each other (different indices ( $p\text{-value} \leq \alpha (0.05)$ )), and other median values with no significant difference (same indices ( $p\text{-value} > \alpha (0.05)$ )). It is striking that there is often no significant price difference between multichannel retailers. For instance, for Yogurette, no significant differences were found for three of four multichannel retailers (REWE Online, EDEKA24 and myTime.de). Apparently, the median of prices charged by these multichannel retailers is often the same. In contrast, almost all median prices differ significantly from each other for pure players. Overall, significant price differences can be found between all suppliers and Hypothesis 1 has to be clearly rejected in our analysis.

### 2.2.2 Do Pure Online Traders Price Below Multichannel Retailers?

We know from selected non-food markets such as DVD brands or electronic products that online prices tend to range below offline prices (TANG and XING 2001: 39). This finding is often ascribed to the lower service and consultation costs online retailers are facing in the context of, e.g., electronic products. Following this logic, multichannel retailers are often found to have higher prices than pure online players (see e.g. PAN et al. 2004, or ANCARANI and SHANKAR 2004). As service and consultation costs may not be equally relevant in grocery retailing, we formulate our second hypothesis as follows:

**Hypothesis 2:** *Online prices for chocolate products charged by pure online retailers do not deviate significantly from those of multichannel retailers, as prices can be compared by consumers with very low search costs.*

Yet, some indications of differential prices between pure online traders and multichannel retailers could be already found in Table 2. For instance, all multichannel retailers offered Milka Alpenmilchcrème for less than one Euro, while the prices of the pure players ranged between 1.13 Euros (Lebensmittel.de) and 1.35 Euros (suesswarenhaus24).

In Table 3, the prices of multichannel retailers and pure players are compared. It can be seen that, for instance, that the multichannel retailers offered Ritter Sport Nugat for 0.89 Euros, while the median price of pure online retailers was 1.19 Euros. The absolutely lowest price difference can be observed for Yogurette with 0.20 Euros, the highest for Sarotti Schwarze Herren Edelbitter with 0.80 Euros. Multichannel retailers ranged below online traders in all cases. It is possible to compare median prices for 11 of the 12 national chocolate brand products formally with a non-parametric test, i.e. the Mann-Whitney U test. Computed test statistics suggest in all cases that national chocolate brand products are offered significantly more expensively by pure online retailers than by multichannel retailers. This result is different from studies such as TANG and XING (2001) which came to an opposite conclusion in non-food retailing. Apparently, chocolate bars and DVDs or electronic devices are different with regard to the price structure in online markets and, possibly, food and non-food markets may be generally different in that respect.

Our findings from Tables 2 and 3 suggest that Hypothesis 2 has to be rejected. Each pure player has a higher price level than multichannel retailers. This might be due to the fact that offline trading subsidized online trading (MALCHER 2013). Additionally, pure online players could sell chocolate bars in a combination with other high-value foods or non-foods, which would allow them to capture a price premium on cheaper products such as chocolate bars.

**Table 3.**  
Comparison of Price Levels between Multichannel Retailers and Pure Players (Euro)

Chocolate Products	Multichannel Retailers	Pure Online Retailers
Milka Alpenmilch	0.89 <sup>a</sup>	1.19 <sup>b</sup>
Milka Alpenmilchcrème	0.89 <sup>a</sup>	1.22 <sup>b</sup>
Milka Noisette	0.89 <sup>a</sup>	1.22 <sup>b</sup>
Ritter Sport Edel-Vollmilch	0.89 <sup>a</sup>	1.11 <sup>b</sup>
Ritter Sport Nugat	0.89 <sup>a</sup>	1.19 <sup>b</sup>
Alpia Alpenmilch	0.65 <sup>a</sup>	0.89 <sup>b</sup>
Alpia Edel-Nougat	0.65	n.a.
Kinder Schokolade	0.99 <sup>a</sup>	1.29 <sup>b</sup>
Yogurette	0.99 <sup>a</sup>	1.19 <sup>b</sup>
Toblerone	1.19 <sup>a</sup>	1.69 <sup>b</sup>
Sarotti Schwarze Herren Edelbitter	1.19 <sup>a</sup>	1.99 <sup>b</sup>
Lindt Excellence 70 % mild	1.95 <sup>a</sup>	2.18 <sup>b</sup>

Notes: This table shows the median in Euros for the operating forms multichannel retailers and pure players. n.a.: Not calculable due to missing data. <sup>a, b</sup> Median values with the same superscript index are not significantly different from each other.

Source: Own computations.

### 2.2.3 Are Online Prices of Multichannel Retailers Lower than Their Offline Prices?

There is some indication that multichannel food retailers apply identical pricing strategies offline and online. Real communicates a price promise, pointing out that the prices online are the same as in retail stores (HANKE and WESP 2010). At the time of data collection in 2013, Rewe and Edeka also made this price promise. Although Rewe clearly communicated recently that the online prices may deviate from the offline prices (REWE.DE 2016), we formulate our hypothesis on the basis of the earlier statements of the German multichannel retailers.

**Hypothesis 3:** *Online prices for chocolate products charged by multichannel retailers do not deviate significantly from the respective offline prices, as the retailers follow uniform pricing strategies.*

In Table 4, the prices of chocolate bars offline and online for three multichannel retailers from our sample are displayed. The differences between the current prices on the observation day are shown as well.

25 % of the REWE Online prices were identical to prices in the Rewe supermarket. Seven products were more expensive online than offline, which might be due to regional differences in offline prices: the reference market for the online survey is a store in Frankfurt, while our data were collected in Giessen. It is possible that prices in the Rewe in Frankfurt are higher and, therefore, closer to the REWE Online prices. The price level offered by Real corresponded online exactly to the price level offline, with the one exception of Kinder Schokolade. Hence, Real kept its price promise. Finally, Edeka showed large differences between prices online and offline. Only Yogurette was offered online at the same price as offline, while all the other prices were higher online. Five products showed an online price which was 0.20 Euros above the offline price, suggesting that Edeka generally charged higher prices online than offline.

**Table 4.**  
Comparison of Online and Offline Prices of Multichannel Retailers (Euro)

Chocolate Products	Rewe			Real			Edeka		
	Online	Offline	$\Delta$	Online	Offline	$\Delta$	Online	Offline	$\Delta$
Milka Alpenmilch	0.95	0.89	0.06	0.89	0.89	0.00	0.95	0.89	0.06
Milka Alpenmilchcrème	0.95	0.89	0.06	0.89	0.89	0.00	0.95	n.d.	n.a.
Milka Noisette	0.95	0.89	0.06	0.89	0.89	0.00	n.d.	0.89	n.a.
Ritter Sport Edel-Vollmilch	0.89	0.85	0.04	n.d.	0.85	n.a.	1.09	0.89	0.20
Ritter Sport Nugat	0.89	0.85	0.04	n.d.	0.89	n.a.	1.09	0.89	0.20
Alpia Alpenmilch	0.65	0.59	0.06	0.49	0.49	0.00	n.d.	0.59	n.a.
Alpia Edel-Nougat	0.65	n.d.	n.a.	0.49	0.49	0.00	n.d.	n.d.	n.a.
Kinder Schokolade	0.99	0.99	0.00	0.95	1.09	-0.14	1.19	0.99	0.20
Yogurette	0.99	0.99	0.00	1.09	1.09	0.00	0.99	0.99	0.00
Toblerone	1.29	1.25	0.04	1.19	1.19	0.00	1.39	1.19	0.20
Sarotti Schwarze Herren									
Edelbitter	0.99	0.99	0.00	n.d.	0.99	n.a.	1.19	0.99	0.20
Lindt Excellence 70 % mild	1.95	1.95	0.00	n.d.	1.95	n.a.	n.d.	1.49	n.a.

Notes:  $\Delta$ : Difference between the price online and offline. n.a.: Not calculable due to missing data; n.d.: not distributed.

Source: Own computations.

We could not arrive at a uniform conclusion regarding Hypothesis 3. It seems that multichannel retailers in our sample pursue different pricing patterns online and offline. However, other recent research suggests that in the following years the pricing online and offline for multichannel retailers will probably converge and become identical (ERNST & YOUNG 2014).

#### 2.2.4 Are Online Prices Flexible?

While offline retailing is often characterized by having very rigid prices once price promotions are taken into account (HERRMANN et al. 2005, LOY and SCHAPER 2014), online pricing might enjoy lower costs of price adjustments (SMITH et al. 2000), which results in the following hypothesis:

**Hypothesis 4:** *Prices online are frequently adjusted and do not remain unchanged for many weeks as in conventional retail stores since the costs of price adjustment are very low online.*

Table 5 reports the range ( $R$ ), i.e. the difference between the highest and the lowest price, the standard deviation ( $s$ ) and the coefficient of variation ( $CV$ ). Across eight retailers, twelve products and three months of data, only twelve cases of price changes were observed. EDEKA24, myTime.de, Foodstore and World of Sweets have not adjusted their prices a single time, while suesswarehaus.de rounded up Ritter Sport Edel-Vollmilch prices from 1.39 to 1.40 Euros and did not alter any other prices over the entire time period. REWE Online decreased the prices for Ritter Sport products for a week during the sample period, real,- Drive used promotion actions four times during the surveyed period.



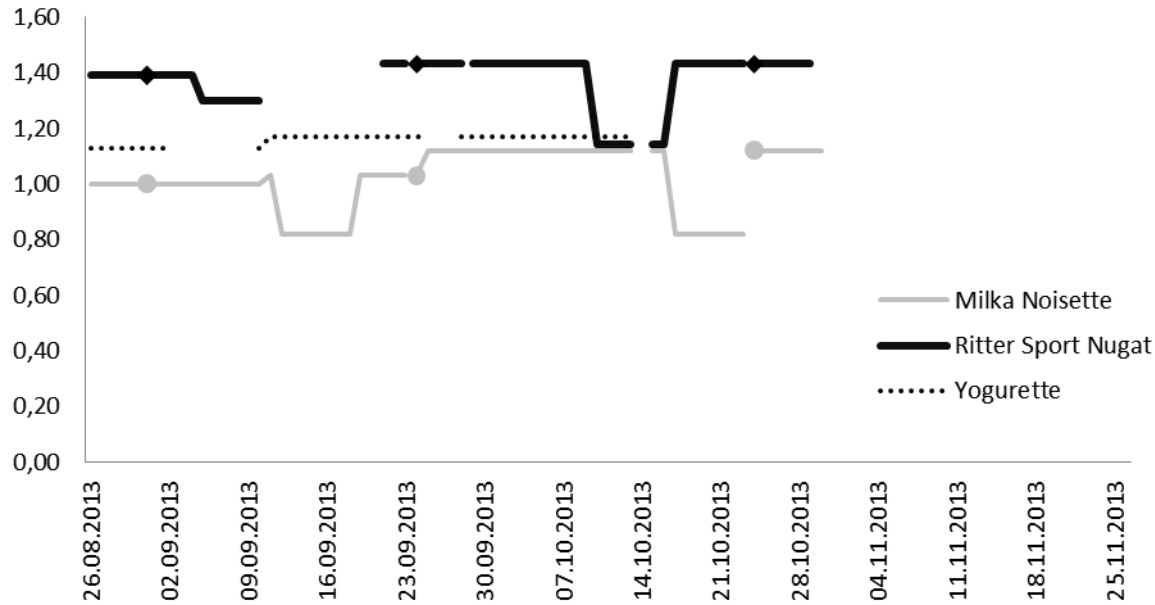
**Table 5.**  
Comparison of Price Volatility for Individual Retailers

Chocolate Products	REWE Online			real,- Drive			EDEKA24			myTime.de			Lebens-mittel.de			Foodstore			World of Sweets			suesswaren-haus24		
	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>	<i>R</i>	<i>s</i>	<i>CV</i>
Milka Alpenmilch	0.00	0.00	0.00	0.30	0.08	9.12	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.
Milka Alpenmilchcrème	0.00	0.00	0.00	0.30	0.08	9.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Milka Noisette	0.00	0.00	0.00	0.30	0.08	9.12	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.11	11.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ritter Sport Edel-Vollmilch	0.24	0.06	7.26	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.31
Ritter Sport Nugat	0.24	0.06	7.26	0.20	0.07	8.26	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.14	10.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alpia Alpenmilch	0.00	0.00	0.00	0.10	0.04	7.53	n.a.	n.a.	n.a.	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.
Alpia Edel-Nougat	0.00	0.00	0.00	0.10	0.04	7.53	n.a.	n.a.	n.a.	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Kinder Schokolade	0.00	0.00	0.00	0.14	0.06	6.21	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yogurette	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	1.47	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Toblerone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sarotti Schwarze Herren Edelbitter	0.00	0.00	0.00	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00	0.00	0.00	0.00	0.00
Lindt Excellence 70 % mild	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00	0.00	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.00	0.00	0.00	n.a.	n.a.	n.a.

Notes: This table shows the range (*R*), the standard deviation (*s*) and the coefficient of variation (*CV*) for every retailer. n.a.: Not calculable due to missing data.

Source: Own computations.

The only retailer that may distinguish itself by a flexible price-setting is Lebensmittel.de. While just six out of twelve products are available at this provider, prices of three chocolate products have been adjusted a few times during the two out of three months in our sample, for which price data for Lebensmittel.de are available. In Figure 1, the price development for these three chocolate bars is shown. At the end of the sample period, none of the twelve chocolate bars was offered anymore.



**Figure 1.** Price Dynamics for Chocolate Bars at Lebensmittel.de (Euro)

Source: Own data collection.

Some variations during the observation period are visible. The price range  $R$  for Milka Noisette was 0.30 Euros and for Ritter Sport Nugat 0.40 Euros. It is remarkable that these values did not result from special offers, but were caused by frequent price changes. During those 65 days on which Milka Noisette was available at Lebensmittel.de, the price was changed six times. Yet, these frequent price changes of Lebensmittel.de are our only evidence in support of Hypothesis 4, suggesting that this firm regards price adjustment costs as being negligible. Apart from this rather exceptional case, prices online seem to be sticky, as they are in brick-and-mortar grocery stores. This finding is in line with recent evidence in BERKA et al. (2011) for the case of Swiss online grocery retailing.

### 3 Multivariate Analysis of the Determinants of Online Chocolate Prices

In this Section we move from bivariate tests to a model in which we explain prices within a multivariate panel-model approach. In all models, the price of a chocolate product is a function of time-, product- and retailer-specific effects. One main objective is to test whether prices statistically differ between retailers in our sample once we control for prices of individual products and their development over time (Table 6, Model 1). In Model 1, EDEKA24 is used as a reference category for retailers and the first date of sample – as a reference for time effects. In Model 2, we substitute retailer-specific effects by dummies for a retailer being a pure online player or a multichannel retailer (reference category) to quantify an average difference between their prices. Finally, in Model 3 we decompose the online price effect and additionally test whether there is any statistically significant difference between prices of Lebensmittel.de and the three Amazon-based online retailers. Foodstore, suesswarenhaus24 and World of Sweets might benefit from Amazon's reputation and loyal clientele, which could result in higher prices. In Model 3, multichannel retailers are used as a reference category for a comparison between multichannel and pure online retail prices. Moreover, Lebensmittel.de is used as a reference category for a comparison between its prices and prices of Amazon-based retailers. In all three models, day 1 is used as a reference category for time effects, which are not reported in the table due to space constraints.

**Table 6.**  
Outcomes of Three Panel Models with Various Time-, Product- and Retailer-specific Effects

	(1)	(2)	(3)
Milka Alpenmilch	1.02*** (0.01)	0.90*** (0.02)	0.90*** (0.02)
Milka Alpenmilchcrème	1.01*** (0.01)	0.91*** (0.02)	0.91*** (0.02)
Milka Noisette	0.99*** (0.01)	0.89*** (0.02)	0.90*** (0.02)
Ritter Sport Edel-Vollmilch	0.97*** (0.01)	0.89*** (0.02)	0.89*** (0.02)
Ritter Sport Nugat	1.00*** (0.01)	0.90*** (0.02)	0.91*** (0.02)
Alpia Alpenmilch	0.71*** (0.01)	0.56*** (0.02)	0.57*** (0.02)
Alpia Edel-Nougat	0.73*** (0.01)	0.60*** (0.02)	0.60*** (0.02)
Kinder Schokolade	1.11*** (0.01)	1.02*** (0.02)	1.02*** (0.02)
Yogurette	1.08*** (0.01)	0.97*** (0.02)	0.98*** (0.02)
Toblerone	1.36*** (0.01)	1.27*** (0.03)	1.27*** (0.02)
Sarotti Schwarze Herren Edelbitter	1.29*** (0.01)	1.23*** (0.03)	1.23*** (0.02)
Lindt Excellence 70 % mild	2.06*** (0.01)	1.91*** (0.02)	1.91*** (0.02)
myTime.de	-0.12*** (0.00)		
Real,- Drive	-0.15*** (0.00)		
REWE Online	-0.10*** (0.00)		
Foodstore	0.18*** (0.00)		
Lebensmittel.de	0.16*** (0.01)		
suesswarenhaus24	0.44*** (0.01)		
World of Sweets	0.13*** (0.01)		
Online		0.32*** (0.01)	0.25*** (0.01)
Amazon-based			0.08*** (0.01)
Adj. R-squared	0.93	0.86	0.86

Notes: White standard errors are reported in parentheses. \*\*\*, \*\* and \* refer to statistical significance at 0.1, 1 and 5% respectively. We do not report estimated coefficients for 92 time-specific effects here due to space constraints. These coefficients are not statistically significant. The complete estimation outcomes are available on request. Source: Own computations.

Our results suggest that price levels across retailers vary significantly, once we control for product- and time-specific effects. EDEKA24, which is used as a reference category, is the most expensive of multichannel retailers (the coefficients related to myTime.de, real,- Drive and REWE Online are negative), yet cheaper than any of the pure online players. Suesswarenhaus24 has on average the highest prices in our sample. Formal F-tests (not reported here) confirm the inequality of retailer-specific effects, supporting our earlier hypothesis of price dispersion among retailers in the sample. High dispersion in online retail prices observed in our sample is in line with earlier studies on non-food products (see e.g. PAN et al., 2004, for an overview), yet our comparison of pure online players' prices to multichannel retailer prices deviate from earlier findings. For instance, TANG and XING (2001) and ANCARANI and SHANKAR (2004) suggest that multichannel retailers set prices higher than pure online players. Prices of multichannel retailers are lower in our sample: the difference between prices of pure online and multichannel retailers is estimated at 0.32 Euro. Here our multivariate tests again support the bivariate statistical analysis of Section 2. This possibly captures a structural difference between food and non-food retailing.

The price dispersion between pure players and multichannel retailers might be due to their focus on different groups of customers. Online platforms of multichannel retailers are mostly oriented on clients

from their offline shops. Pure online retailers face different groups of customers, possibly those who have earlier used Amazon or similar providers for non-grocery shopping (ERNST & YOUNG 2014). Due to the relatively early stage of online grocery retailing, market positions of individual retailers are not yet well defined and companies that managed to attract internet clientele earlier can gain trust and hence enjoy loyalty of their customers (see, e.g., REICHHELD and SCHEFTER 2000 or ANANIA and NISTICO 2014) obtained through providing them with positive online shopping experience (MELIS et al. 2015) and various lock-in effects (VARIAN 1999). This seems to be the case in point in our sample, which is demonstrated by results of Model 3. Here we test whether Amazon-based retailers price their products differently from Lebensmittel.de. It turned out that while prices at Lebensmittel.de are 0.25 Euro higher than prices of multichannel retailers, three Amazon-based retailers set on average prices that are 0.08 Euro higher than that. Already CLAY et al. (2002) suggested that Amazon belongs to the most expensive stores. This is possible as Amazon has capacities to use strategic marketing and employs large advertising budgets to develop high awareness across potential consumers, which makes it difficult for them to locate other retailers (SMITH et al. 2000). These marketing measures are probably not directly targeted at grocery retailers that use Amazon as their online platform. However, it might well be that Amazon-based confectionery providers can benefit from these information campaigns.

Finally, time-specific effects are not significant in any of the three estimated models. These outcomes support our earlier finding of relatively rigid prices in online and multichannel retailing and are in line with BERKA et al. (2011).

#### 4 Summary and Conclusions

Despite the increasing role of online markets for foods, studies on those markets in general and on price formation in particular have been rare. We contribute to the issue by investigating price setting on the German online market for chocolate empirically. Online prices were collected daily for eight major pure online and multichannel retailers and twelve products over a three-month period. We formulated a few hypotheses regarding price levels and dispersion which were tested using means of descriptive and inductive statistics and also assessed in a multivariate panel-model approach. Our major findings can be summarized as follows:

- i. Major suppliers on the online market do not price homogeneous products identically. Apparently, reduced search costs due to readily available price information are compensated by other non-price factors so that price differentials persist (see e.g. DEGERATU et al. 2000 for more information on price sensitivity online).
- ii. There is a very clear pattern in median and mean online prices across different groups of retailers. Prices of pure online players are significantly higher than prices of multichannel retailers. Multichannel retailers do not seem to follow a single pattern on pricing online and offline yet. ERNST & YOUNG (2014) claim, however, that multichannel retailers will homogenize their online and offline prices as well as services in the near future. The results of our panel model suggest that multichannel prices are lower than prices of pure online retailers, contrary to findings of earlier studies. The discrepancy in prices might be due to a difference in target groups that food retailers focus on: while consumers of multichannels' online platforms tend to be consumers of a related online store, clients of pure online retailers could have earlier used services of Amazon for non-food products and appreciated the functionality of the platform, eventually enlarging their product basket to groceries.
- iii. Several multichannel retailers do not deviate significantly in their typical price level for the analyzed products online and offline, whereas one multichannel retailer offered most chocolate products online at higher prices than offline. This is very different from the non-food sector, where lower online prices have been identified as a threat for the established retailing sector.
- iv. Although price adjustments can be realized easily and cheaply on online markets, online prices are highly rigid. While data suggests that Lebensmittel.de is the only retailer that often adjusts prices, time-specific effects in our panel model point out that prices do not significantly deviate from the reference date at any point of our sample.

Our results suggest that – at least for the case of chocolate – despite the predictions of the theory of information economics, a growing online market leaves customers with highly heterogeneous prices for homogeneous commodities. Apparently, search costs are not the only factor that influences price formation and price is not the only factor that determines the consumer's choice of the retailer.

More research is needed to address the issue of consumer heterogeneity in their online and offline choices and their willingness to pay an (extra) price for certain features of online shopping. While some

first steps in this direction are undertaken for non-food products, the heterogeneity of choice seems to be only weakly correlated with standard consumer attributes (NEVO 2010) and hence, remains a mystery and a major task for further research.

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