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**Article**

## The Dose Makes the Poison - Dynamic Pricing Strategies and Their Influence on Consumers

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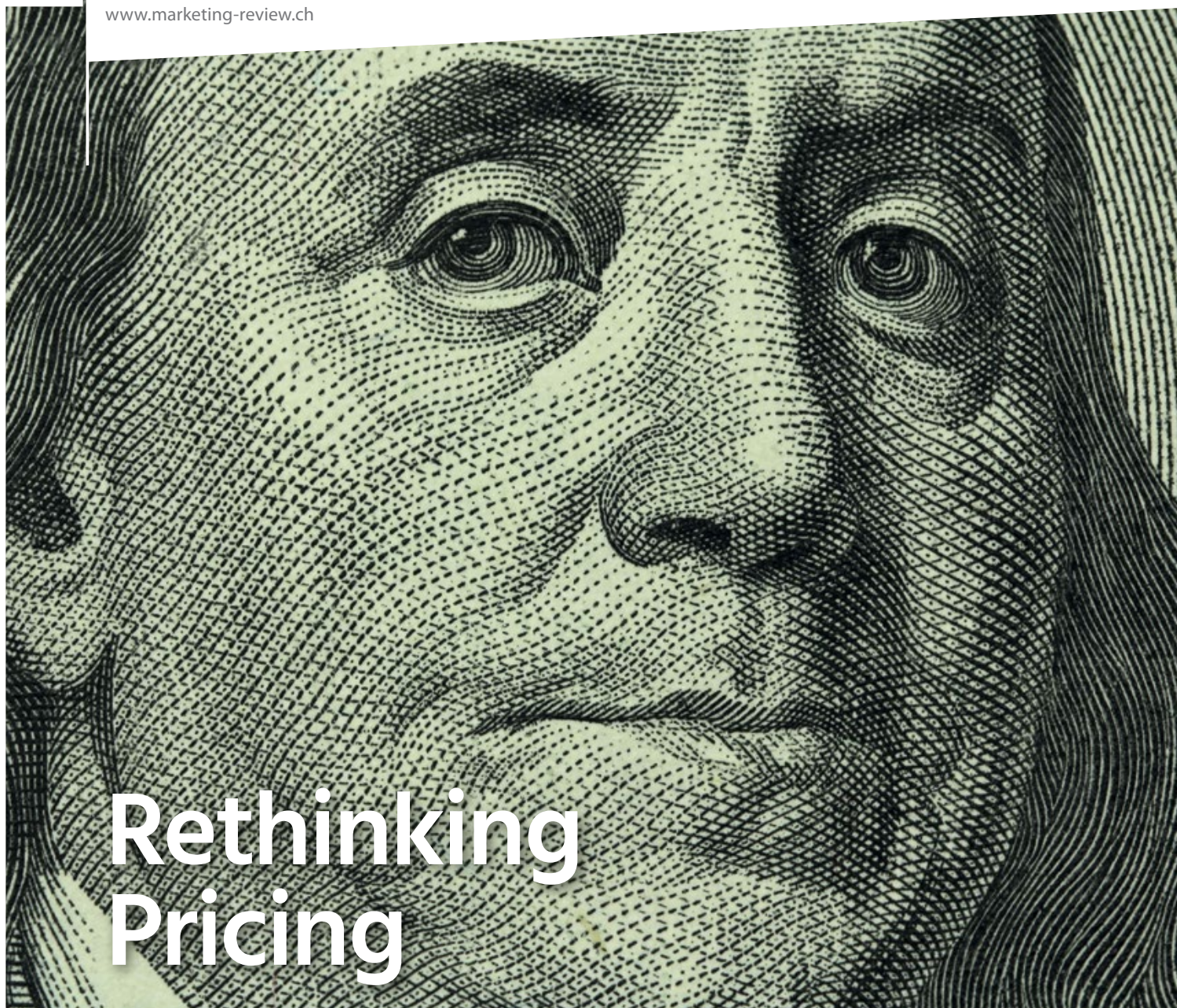


# Marketing Review St. Gallen



5 | 2019 **SCHWERPUNKT** Das Geschäft mit der Transparenz • Dynamic Pricing – Influence on Consumers • Dynamisches Pricing in der Kundenwahrnehmung • Akzeptanz von Dynamischen Preisen – Fallstudie • Umsetzung von Dynamic Pricing • Applicability of Pay-What-You-Want Strategies **GASTBEITRAG** Die Philosophie des Preises **KOMMENTAR** Marketing Intelligence – oder gibt es noch etwas anderes? **SPEKTRUM** Trends in der Customer-Journey • Lead-Generierung • Conversational Agents aus der Kundenperspektive

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## Rethinking Pricing

# The Dose Makes the Poison

## Dynamic Pricing Strategies and Their Influence on Consumers

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To study price dynamics of the Swiss online retail market, prices of 1200 products from 299 retailers were observed for 50 days. The authors identified four dynamic pricing strategies, compared the price changes of pure online and cross-channel retailers and measured how dynamic pricing influences retailers' value for money ratings.

**Prof. Dr. Thomas Rudolph, Gianluca Scheidegger, Elias Barth, Dr. Marc Linzmajer**



In the past, menu costs—the costs associated with changing prices (e.g. by reprinting the restaurant menu or a price tag)—have prevented retailers from frequently adapting their prices. Economists refer to this issue as “price stickiness” (e.g. Laidler, 1996). In addition, the lack of price comparison websites implied high search costs for consumers looking for the best prices. Under these circumstances, it was more costly and time-consuming for retailers to adapt prices frequently.

However, technology has lowered search costs and increased price transparency. Consumers can easily compare prices and buy the product with the lowest price. As a result, prices are less sticky today. Instead, dynamic pricing strategies have become normal in many industries (e.g. McAfee & te Velde, 2006; Abrate, Fraquelli & Viglia, 2012). For example, airlines and hotels use algorithms to adjust their prices based on sales and capacity. Gas prices fluctuate heavily with the demand and supply of crude oil, and theme parks adjust prices during holiday seasons. Nowadays, the rise of e-commerce and the low costs of changing a digital price have led to increasing price changes in the retail sector as well. While it is known that big international online retailers, such as Amazon, change their prices several million times a day (Mehta, Detroja & Agashe, 2018), little is known about the price dynamics of a whole country’s online and cross-channel market. It is also unclear to date how consumers perceive different dynamic pricing strategies.

Therefore, this article seeks to analyse to what extent Swiss pure online retailers (PORs) and cross-channel retailers (CCRs) engage in dynamic pricing. To this purpose, the authors observe the most popular online shopping items over a period of fifty days to provide a descriptive analysis of Swiss online price dynamics. Based on this data, the authors identify and categorise the most common dynamic pricing strategies and highlight the differences between PORs and CCRs. Eventually, consumer ratings are used to analyse how the identified dynamic pricing strategies influence consumers’ value for money ratings.

## Conceptual Framework

In line with Klein and Steinhardt (2008), this publication defines dynamic pricing as a pricing strategy in which a retailer adapts prices at any time in reaction to changes in demand or competition to maximise total revenue. Hence, in the context of this research, dynamic pricing only relates to time-based price discrimination. This means every customer sees the same price at the same time.

### Channel Differences in Price Dynamics

From a retailer perspective, PORs have almost no marginal costs when changing prices. Thus, they can quickly react to

changing consumer demand or price changes of their competitors without incurring any costs. Therefore, PORs are more likely to change prices more frequently to maximise their profits.

Even though the necessary technology, such as electronic shelf labels (ESLs), has been available for more than two decades, high investment costs for ESLs as well as low consumer acceptance (e.g. due to poor readability and price fairness concerns) have prevented many retailers from switching to this technology (Comtesse, 2010). Today, the majority of brick and mortar stores in the DACH area (Germany, Austria, Switzerland) are still equipped with non-electronic shelf labels. As recent literature on multichannel pricing suggests, CCRs should try to synchronise their pricing activities across all channels (Grewal, Hardesty & Iyer, 2010), with only few exceptions (Homburg, Lauer & Vomberg, 2019). Discriminating prices across channels could be perceived as unfair by customers (Xia, Monroe & Cox, 2004; Haws & Bearden, 2006). In fact, today the majority of CCRs synchronises its prices and price changes

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online and offline (Cavallo, 2017). Therefore, the authors expect that CCRs are less likely to engage in dynamic pricing:

*(H1) Cross-channel retailers will have lower price fluctuations than pure online retailers.*

### Effects of Dynamic Pricing

To better understand consumer reactions to dynamic pricing, this study analyses if and how dynamic pricing strategies influence consumers' price perception for Swiss PORs and CCRs. Previous research has shown that dynamic pricing strategies may lead to negative outcomes for retailers (e.g. Garbarino & Lee, 2003; Haws & Bearden, 2006; Garbarino & Maxwell, 2010). This is because demand-based and economically motivated price changes can be considered unfair by customers (Kahnemann, Knetsch & Thaler, 1986; Dickson & Kalapurakal, 1994; Bolton, Warlop & Alba, 2003; Xia et al., 2004; Grewal et al., 2004). In an online experiment, Garbarino and Lee (2003) showed that dynamic pricing reduces consumers' trust in the benevolence of retailers. Garbarino and Maxwell (2010) argue that consumers may perceive dynamic pricing as a norm-breaking pricing event leading to unfairness perceptions, reduced trust in the retailer and higher complaint intentions. Haws and Bearden (2006) showed that time-based price differences negatively influence consumers' price fairness perception and purchase satisfaction. Homburg et al. (2019) demonstrate that consumers only accept offline price premiums of approximately 2%. However, field evidence of these negative effects has up to now mainly been limited to media coverage. In fact, public interest in dynamic pricing has increased in recent years. The media has published much anecdotal evidence of consumers' aversion to dynamic pricing practices in different contexts, such

as skiing tickets (Auras, 2019; Krückl & Bolzli, 2019), retailing (Heininger, 2018; Mehta et al., 2018) or mobility services (Pfanter, 2016; Hecking, 2019; Sugar, 2019). Based on these arguments, the authors assume a negative connection between dynamic pricing and perceived price fairness. Yet, as price fairness perception is hard to measure in secondary field data, the authors will operationalise the theoretical construct of "price fairness perception" by looking at retailers' value for money ratings in the data analysis section. The value for money ratings can be seen as an indicator of price fairness perception ratings as used in previous experimental studies (e.g. Dickson & Kalapurakal, 1994; Xia et al., 2004; Garaus, Wolfsteiner & Wagner, 2016).

*(H2) Dynamic pricing leads to less favourable value for money ratings of the specific retailer.*

Based on H2, the authors expect that consumers shopping at retailers who engage heavily in dynamic pricing show lower levels of perceived value for money. This implies that consumers are able to perceive price differences over time. However, the Weber-Fechner Law (e.g. Monroe, 1973; Thaler, 1980; Monroe & Lee, 1999; Sirvanci, 2016) states that there is a difference between the actual change in a stimulus (e.g. a price) and the perceived change of this stimulus (Monroe, 1973). Changes below a certain threshold (also known as "just noticeable difference") which vary in proportion to the stimulus will not be noticed by recipients (Britt & Nelson, 1976). This means that small and frequent price changes may remain unnoticed by consumers and might not affect consumers' value for money perceptions. In contrast, infrequent and large price changes are expected to lower consumers' value for money perception:

*(H3) The magnitude of price changes will have a stronger negative effect on value for money ratings than the frequency of price changes.*

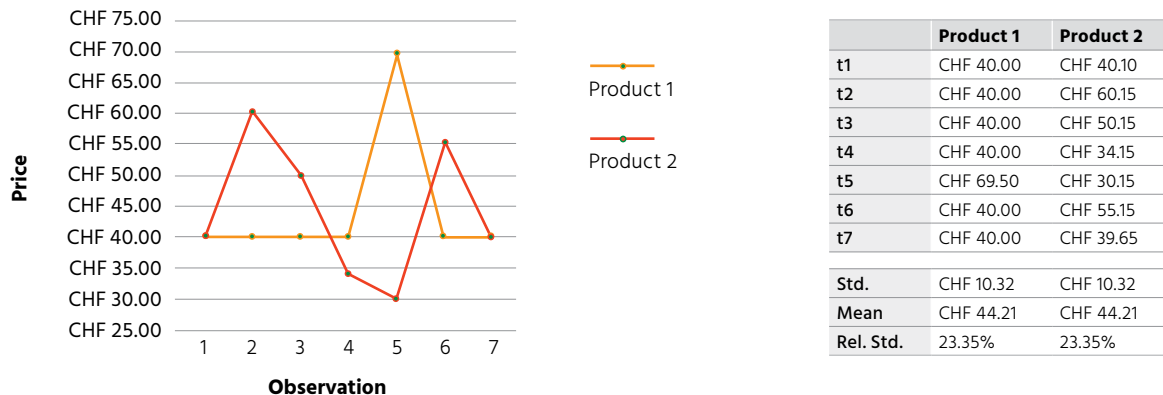
### Management Summary

Latest technology allows retailers to dynamically adapt their prices. As a result, many retailers rethink their current pricing strategy. This article analyses this development by identifying four dynamic pricing strategies of cross-channel and pure online retailers in the Swiss retail market. The article then investigates the consequences of these four strategies on customers' value for money evaluations.

### Data Analysis

#### Data Collection

Starting from January 4th and up to February 23th, 2019 (50 days), the authors collected publicly available price information of 1200 products from 12 different categories on the Swiss price comparison website "toppreise.ch". For all of the 1200 products, prices (excl. shipping costs) were collected three times per day (every 8 hours – at 1 am, 9 am and 5 pm Central European Time)<sup>2</sup> for 50 days using a web-scraping tool. The

**Figure 1: Limitations of Relative Standard Deviation as a Measure for Price Fluctuation**

Source: Own Illustration.

selected products in the data sample stem from toppreise.ch's list of the 100 most popular products per category. Toppreise.ch uses the number of price searches for a product as an indicator of its popularity. The final, adjusted<sup>3</sup> dataset consists of 3,044,625 data points from 24,817 individual retailer-product combinations. Throughout this article, the authors refer to "retailer-product-combination" as a specific product offered by a specific retailer (e.g. iPhone X sold by digitec.ch ≠ iPhone X sold by microspot.ch).

### Price Fluctuation Metrics

In order to determine to which extent Swiss PORs and CCRs engage in dynamic pricing the authors first had to quantify the observed price fluctuations. Economists usually express the fluctuation of prices (e.g. crude oil price; Ferderer, 1996) by the standard deviation. The standard deviation expresses the degree of variation in a series of data. Dividing the standard deviation by the mean value of the respective series of data leads to the relative standard deviation. The relative standard deviation makes variation comparable across products of significantly different price categories. While relative standard deviation is an accurate metric to express the price fluctuation of product prices, it has some limitations, as illustrated by the following examples.

Figure 1 shows the price chart of two exemplary products. Product 2 exhibits various price changes, suggesting a higher variability than in product 1. However, the standard deviation, the mean and thus the relative standard deviation are identical. Product 1 has one relatively large price change, whereas product 2 shows seven rather small variations. Both types of

changes influence the mean and standard deviation values in the same way.

To allow differentiated statements on the dynamics of product prices over time, price fluctuation was calculated in two different ways:

1. price fluctuation as an expression of the magnitude of price changes and
2. price fluctuation as an expression of the frequency of price changes.

The relative standard deviation formula was used to calculate price fluctuation magnitude (PFM): The standard deviation of product A's price sold by retailer B over 50 days was divided by the mean price of product A sold by retailer B and multiplied by 100. In doing so, the result is a percentage value that can compare the PFM of various products, even if their average prices are significantly different (e.g. iPhone X vs LEGO set). Price fluctuation frequency (PFF), on the other hand, is calculated by counting the number of distinct prices product A is offered for by retailer B over the period of 50 days, divided by the total number of price observations for product A at retailer B. If a product shows no price fluctuations at all, the distinct price count will be at least 1. Therefore, 1 is subtracted from the count of distinct prices before it is divided by the total number of price observations. The calculations are summarised in the formulas below:

$$(1) \text{ PFM in \%} = \frac{\text{Standard deviation (product price)}}{\text{Mean (product price)}} * 100$$

$$(2) \text{ PFF in \%} = \frac{\text{Number of distinct prices per item and retailer} - 1}{\text{Number of price entries per item and retailer}} * 100$$

<sup>1</sup> For more information regarding the platform toppreise.ch, see [www.toppreise.ch](http://www.toppreise.ch).

<sup>2</sup> Due to the large amount of data and the complexity of scraping all URLs at the same time, sometimes the data was collected a few minutes behind schedule.

<sup>3</sup> Some of the 1200 product links were structured differently (about 10%). Therefore, our scraping algorithm did not reliably gather the price information of all products at all times. Consequently, all products with less than 50 price entries (one per day) were removed.

### Cluster Analysis

In the next step, the authors used the fluctuation metrics to measure how actively retailers engage in dynamic pricing. In addition, to identify dominant pricing strategies, x-means cluster analysis was performed to categorise all 299 retailers according to their average price fluctuation magnitude and frequency values. X-means is a clustering algorithm based on k-means clustering which helps to identify the accurate group numbers more efficiently based on the Bayesian and Akaike information criteria (Pelleg & Moore, 2000). The calculations led to an optimal group size of 4 with an average cluster distance of 0.598 and a Davies–Bouldin index of 0.802 (Davies & Bouldin, 1979). Figure 2 illustrates the following four dynamic pricing strategy clusters:

- About two thirds of the observed retailers still avoid dynamic pricing. Instead, they fall into the Same Price Strategy cluster. In this cluster, retailers stick to their prices and avoid price changes.
- The Hybrid Strategy is the second largest cluster observed, with 24% of retailers. It is characterised by moderate price changes in both price dimensions.
- Two extreme strategies were identified: 11% of retailers fall into the Magnitude Strategy cluster, which shows high PFM and low to moderate PFF values.
- In contrast to this, the Frequency Strategy exhibits high PFF and low to moderate PFM values.

### Channel Differences

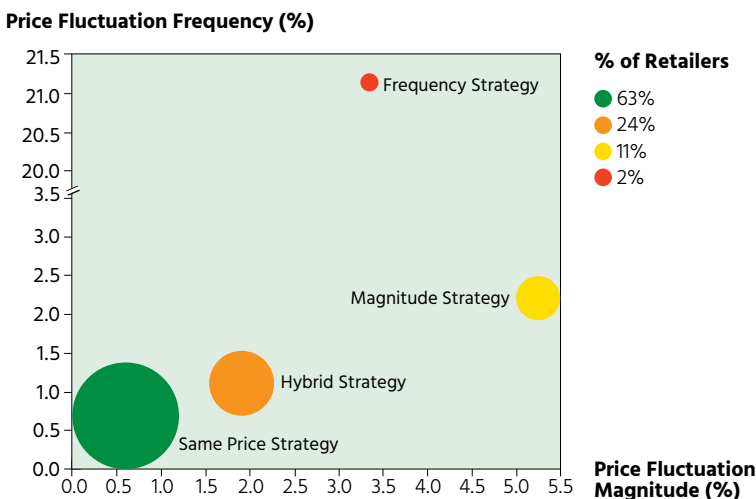
The authors conducted an independent-samples t-test to assess the influence of retail formats (PORs and CCRs) on the formulation of pricing strategies. First, all retailers were coded according to their retail format using the information available on the retailers’ websites. Retailers without any brick and mortar stores were considered as PORs. Online retailers with a pick-up station also fell into this category, as the products can still not be bought offline. Then, price fluctuation differences of all retailer-product combinations (N = 24,817) were compared between the two retail formats. CCRs (M = 1.51%, SD = 3.44%) showed significantly lower (t(24,648.92) = -18.19, p = 0.00) PFF scores than PORs (M = 2.36%, SD = 3.93%). The same holds true for PFM scores. Again, CCRs’ scores (M = 2.04%, SD = 4.41%) were significantly lower (t(21,168.38) = -3.60, p = 0.00) than those of PORs (M = 2.23%, SD = 3.59%). In sum, product prices offered at PORs are more dynamic than prices offered at CCRs. The results illustrated in Figure 3 confirm H1: CCRs show lower levels of price fluctuations.

### Effects of Dynamic Pricing

After identifying the most common pricing strategies, consumer ratings from toppreise.ch were used to evaluate price fluctuation effects on consumers’ value for money ratings. Based on previous research, the authors hypothesised that dynamic pricing leads to negative price fairness perceptions. To allow differentiated statements on how each pricing strategy influences price fairness perception, both price fluctuation dimensions (magnitude and frequency) were considered in the following calculations.

For this analysis, 105,469 retailer ratings in the category “value for money” were added to the dataset.<sup>4</sup> On toppreise.ch, consumers can rate all retailers across different categories on a scale from 1 to 6. In an ordinary least squares regression with mean-centred PFF values, as well as mean-centred PFM values, their interaction as predictors, and value for money ratings as a dependent variable, the influence of price dynamics on consumer perceptions was tested. While the overall regression model was significant (F(3, 171) = 5.813, R<sup>2</sup> = 9.250%, p = 0.001), only PFM (b = -0.106, p = 0.000) had a significant negative influence on consumers’ value for money ratings. PFF (b = -0.013, p = 0.347) and the interaction term (b = 0.012, p = 0.505) had no significant effect on the ratings. As the sample sizes in extreme clusters were low (N < 30), a statistical analysis

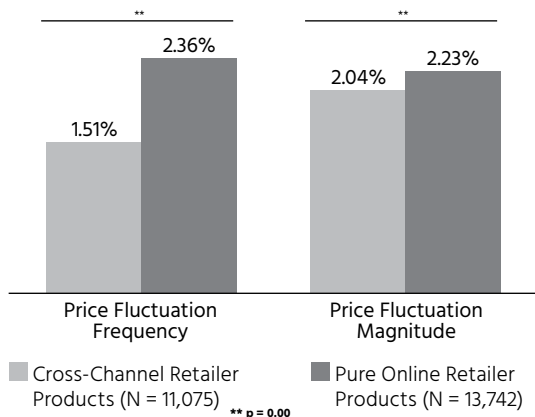
**Figure 2: Dynamic Pricing Strategy Clusters**



Source: Own Illustration.

<sup>4</sup> Out of 299 retailers, 175 were rated by customers.

**Figure 3: Mean Fluctuation Differences Between Cross-Channel and Pure Online Retailers**

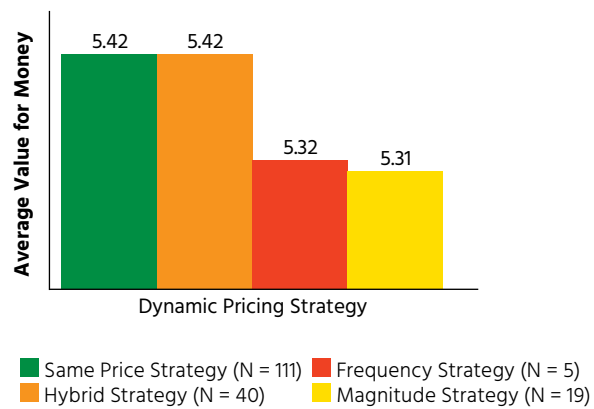


Source: Own Illustration.

for average group differences between the four pricing strategies could not be performed. However, as illustrated in Figure 4, it can be seen that retailers using a same price or hybrid strategy show nearly identical ratings, while frequency and magnitude strategies lead to less favourable perceptions of retailers' value for money.

Even though the differences are statistically significant, the nominal differences are rather small. However, given the

**Figure 4: Average Value for Money Ratings by Pricing Strategy**



Source: Own Illustration.

competitive environment of PORs and CCRs, even such a small difference could potentially lead to a shift in consumers' shop preferences.

### Implications for Retailers and Marketing Research

Table 1 illustrates the real-life mapping of the introduced pricing strategies for the same product "LEGO Technic – Mack Anthem" over the exact same time period of 50 days. Lego products are known to exhibit a stable price development and are easy to compare (Sielen, 2013). Nevertheless, the table shows how heterogeneous retailers are in their pricing approach for the same product. Also, in accordance with the proposed hypothesis, the table shows that PORs (Galaxus and Techmania) engage more actively in dynamic pricing than retailers with a brick and mortar presence (Lego and Toys "R" Us).

Overall, the results of the cluster analysis indicate that retailers are still cautious in their adoption of dynamic pricing. However, the dominance of the same price strategy is surprising. After all, researchers have shown that dynamic pricing can significantly increase profitability (Zhao & Zheng, 2000; Sahay, 2007). Retailers used to avoid price changes because of the high costs associated with them (e.g. menu costs). However, information technology has significantly lowered those marginal costs for

### Main Propositions

1. Based on field data from the Swiss retail market the study identifies four dynamic pricing strategies: Same Price Strategy, Hybrid Strategy, Magnitude Strategy, Frequency Strategy.
2. Two-thirds of retailers still avoid dynamic pricing and follow a same price strategy.
3. Pure online retailers engage significantly more often in dynamic pricing practices than cross-channel retailers.
4. Some extreme pricing strategies can lead to less favorable "value for money" ratings.



online retailers as well as for CCRs. Still, as shown in this study, some CCRs do not yet take advantage of the new technologies and therefore show lower levels of price fluctuation than PORs.

An alternative reason behind the reluctance to use dynamic pricing might be the fear of negative value for money ratings. However, the findings on the effects of dynamic pricing suggest that only the extreme strategies—and especially the magnitude of price changes—lead to negative value for money ratings. There is almost no difference in value for money ratings between the Same Price Strategy

and the Hybrid Strategy. Therefore, consumers do not consider dynamic pricing as negative per se. Only if consumers feel disadvantaged, they perceive prices as unfair, which in turn can lead to lower value for money ratings (Bolton et al., 2003). Therefore, instead of avoiding dynamic pricing altogether, retailers should consider adopting dynamic pricing to increase profitability while maintaining perceived price fairness. As previous research has pointed out, price fairness perception is highly dependent on factors like motives for price changes and competitive prices (Campbell, 1999; Bolton et al., 2003). Thus, retailers who switch from a Same Price Strategy to a dynamic pricing strategy (e.g. Hybrid Strategy) should consider those factors in their pricing strategy. This implies to not only monitor the value for money ratings carefully and to track price fairness with established measurements like the scale items used by Campbell (1999). It also means to clearly communicate the motives behind price changes. For example, retailers may refer to rising costs of raw materials for battery production when increasing the price of a digital camera – assuming, of course, that this is true. In addition, retailers should evaluate their current strategy positioning (same price, hybrid, frequency, magnitude) in comparison to their competitors. Numerous web scraping algorithms, like the one used for this research, simplify the process of gathering price information from competitors. With this publicly available information, retailers can identify their current dynamic pri-

**Table 1: Four Strategies for the Same Product, “LEGO Technic – Mack Anthem”**

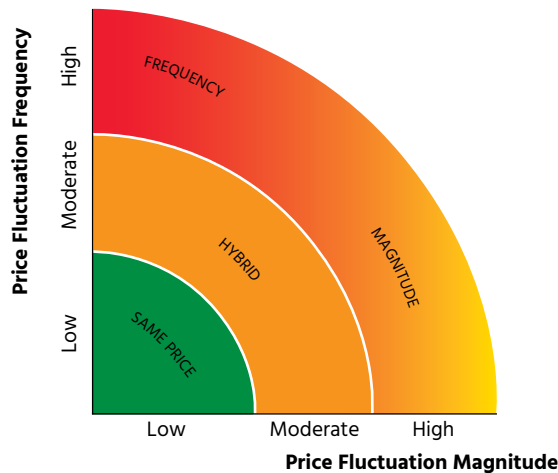
Strategy	Price development over 50 days	Shop	Type	Metrics			
Same Price			Cross-Channel	Min Price	CHF 199	PFM	0.00%
				Max Price	CHF 199	PFF	0.00%
				Distinct Prices	1		
Hybrid			Pure Online	Min Price	CHF 134	PFM	1.19%
				Max Price	CHF 142	PFF	3.33%
				Distinct Prices	6		
Magnitude			Cross Channel	Min Price	CHF 119.90	PFM	13.75%
				Max Price	CHF 179.90	PFF	2.40%
				Distinct Prices	4		
Frequency			Pure Online	Min Price	CHF 131.90	PFM	4.52%
				Max Price	CHF 155.80	PFF	11.94%
				Distinct Prices	17		

Source: Own Illustration.

### Lessons Learned

- 1. Open new doors:** Consumers do not perceive dynamic pricing as negative per se. Therefore, retailers should consider the possibility of engaging in dynamic pricing.
- 2. Handle with care:** Retailers should be careful in using extreme pricing strategies to avoid lower value for money ratings. In doing so, they may use the price magnitude and price frequency thresholds listed in this article as benchmarks.
- 3. Trust is good, control is better:** It is crucial for retailers to regularly control their price positioning in comparison to their competitors and evaluate customers' value for money ratings as a potential indicator of consumer trust.

**Figure 5: Dynamic Pricing Strategy Classification**



Source: Own Illustration.

pricing positioning compared to their competitors. Retailers who are using one of the two extreme strategies should be aware that their current pricing strategy might lower their value for money ratings. Figure 5 provides an overview of the positioning of the pricing strategies that are currently used by Swiss retailers.

The following quote by the Swiss toxicologist Paracelsus (1538/1965, p. 510) nicely sums up the most important implication for retailers: "All things are poison, and nothing is without poison, the dosage alone makes it so a thing is not a poison." In this vein, dynamic pricing is only poisonous to retailers if the dose is too high. But how high is "too high"? While the answer to this question certainly depends on the individual retailer's product category, competitive environment and consumers' price sensitivity, we seek to provide some guidance by listing the PFM and PFF ranges for the different strategy clusters in Table 2. Especially retailers with a weak market position, whose pricing decisions are often influenced by their competitors, can use the value ranges as benchmarks.

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According to our findings, retailers should try to avoid extreme PFM values over 3.71% and PFF values over 3.66% (maximum values of the hybrid strategy). PFM values should be handled with more care as their negative impact on consumers' value for money evaluations is higher. This means that over an observation period of 50 days with 3 daily price observations (150 price observations in total), the price should not be adjusted more than 6 times. At the same time, the standard deviation caused by those price changes should not be higher than CHF 3.71, if we assume a mean price of CHF 100 over the observation period.<sup>5</sup>

From a theoretical perspective, this paper contributes to existing research on dynamic pricing as the self-developed metrics allow retailers and future researchers to quantify the use of dynamic pricing and differentiate between two fluctuation dimensions: frequency and magnitude of price changes. In addition, it fills a gap in the price fairness literature as it provides field evidence on how changes in price fluctuation frequency and price fluctuation magnitude affect con-

**Table 2: PFM and PFF Ranges**

	<b>PFM Range</b>	<b>PFF Range</b>
<b>Same Price Strategy</b>	0.00% – 1.07%	0.00% – 1.36%
<b>Hybrid Strategy</b>	0.79% – 3.71%	0.12% – 3.66%
<b>Magnitude Strategy</b>	2.01% – 25.99%	0.37% – 8.44%
<b>Frequency Strategy</b>	1.20% – 7.25%	14.53% – 33.58%

Source: Own Illustration.

sumers' value for money ratings. Lastly, the findings on channel differences underline the importance of menu cost considerations in the context of dynamic pricing and thereby contribute to the economic literature on market inefficiencies and the establishment of equilibrium prices. As a next step toward a better understanding of dynamic pricing in retail, an in-depth analysis of the interplay between business model type and dynamic pricing strategies may lead to new insights for practitioners and researchers alike. 

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<sup>5</sup> Please note: As shown in Figure 1, many different price combinations can lead to a standard deviation of over CHF 3.71. For example, if six out of 150 price observations are CHF 80 and all other 144 observations are CHF 101, the standard deviation is CHF 4.12 and thus already exceeds the threshold.