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Pricing in the Digital Age:

A Roadmap to Becoming a
 Dynamic Pricing Retailer

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Groningen Digital Business Centre (GDBC)

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Dynamic pricing and personalized pricing emerged as novel pricing approaches in the digital age; shifting to these novel pricing approaches can increase company profits by 3% to 25%. Dynamic pricing allows firms to smoothen demand and supply and to remain competitive facing price pressure. Personalized pricing enables companies to tap into consumers' different willingness to pay.

However, such profit-increases only set in if managers make good choices when implementing their company's pricing approach. Managers need to overcome potential adverse consumer reactions and need to comply with privacy regulations. Managers need to create an appropriate IT infrastructure, synchronize prices in their on- and offline channels, harmonize prices in their product portfolio, and nurture a mindset that is open to automating prices.

In this book chapter, I discuss these aspects and provide practical guidance for decision-makers. This discussion enables managers to decide whether and how to implement a dynamic pricing approach.



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Pricing in the Digital Age: A Roadmap to Becoming a Dynamic Pricing Retailer

Arnd Vomberg, *University of Groningen*

Table 1
The Idea in Brief

The Issue	The Response	The Bottom Line
<ul style="list-style-type: none">• How to price online is of focal importance for firm performance• Online markets offer unique insights on customers and competitors for effective pricing decisions	<p>Technological developments and competitive pressures have resulted in two novel pricing approaches:</p> <ul style="list-style-type: none">• Dynamic pricing• Personalized pricing	<p>Dynamic pricing can increase company performance if managers:</p> <ul style="list-style-type: none">• make appropriate design choices• effectively overcome implementation challenges

1. Dynamic Prices: Overcoming the Paradigm of Fixed Prices

Changes in the way companies set their prices have been in the center of interest for the last decade. Readers of the *Wall Street Journal* most likely have witnessed headlines such as:

- "Coming soon toilet paper priced like airline tickets" (Angwin and Mattioli 2012),
- "The high speed trading behind your Amazon purchase" (Mims 2017), and
- "Now prices can change from minute to minute" (Nicas 2015).

Those headlines address an essential manner in which companies nowadays set their prices: companies more and more break with the last century's norm of fixed prices and move to dynamic prices. Increased data availability and new technologies caused the rise of dynamic pricing. New technologies help companies to identify consumer behavior patterns more quickly and efficiently and to align prices accordingly. Simultaneously, increased online price transparency pressures companies to monitor and respond in real-time to competitive prices (Fisher, Gallino, and Li 2018).

Companies break the norm of fixed prices in two ways. First, online prices fluctuate over time but are the same for all consumers; a practice referred to as time-based dynamic pricing (in the following, I will only call this practice "dynamic pricing"). For example, reporters noted that on Amazon.com, the price for a microwave oven changed nine times during a single day, with prices varying between \$744.46 and \$871.49 (Angwin and Mattioli 2012).

Second, companies offer at the same point in time different prices to different consumers, referred to as consumer-based dynamic pricing (in the following, I will refer to this practice as "personalized pricing" to differentiate it from dynamic pricing clearly). Media reports observed that the price for a monitor in an online shop depended on how the reporter accessed the online shop, either directly or via a price comparison portal. The monitor price was 187€ lower if the reporter accessed the online shop via a price comparison portal.

Investigations demonstrate that retailers can increase their profits with those novel pricing approaches. Depending on the industry, studies indicate a revenue increasing-potential of dynamic pricing between 2% and 8% and potential profit increases between 3% and 25% (BenMark et al. 2017; Kimes and Wirtz 2003). Initial studies also document a profit-generating potential of personalized pricing of 12% (Shiller 2014).

However, whether retailers can benefit from such profit-potentials depends on how they design their pricing approach. For instance, whether they only match competitor prices or account for consumer price elasticity¹ impacts the dynamic pricing approach's effectiveness (Fisher, Gallino, and Li 2018). In this chapter, I will discuss key decisions that retailers need to make.

Moreover, breaking with the norm of fixed prices provokes external and internal implementation challenges that retailers need to address. External challenges stem from potential adverse consumer reactions and stricter regulations (such as privacy regulations). Thus, retailers need to ensure that their pricing approach does not sacrifice long-term consumer relationships for short-term profits. Internal challenges can stem from a company's channel structure, its IT capabilities, and its cultural mindset. For instance, retailers need to nurture a cultural mindset that is open to delegate pricing decisions to algorithms. Additionally, multichannel retailers need to develop a strategy for synchronizing pricing in their online and offline channels.

This chapter is based on state-of-the-art of academic knowledge and industry reports. Moreover, I will refer to in-depth interviews conducted by Vomberg, Lauer, and Weitkämper (2020). These interviews will provide further practical insights which enrich the discussion. Interviews were conducted with eleven online and multichannel retailers (referred to as R1-R11) as well as nine solution providers (i.e., companies that develop commercial dynamic pricing software, referred to as S1-S9) (Vomberg, Lauer, and Weitkämper 2020 offer a detailed sample description).

¹ Price elasticity relates a relative change in demand to a relative price change. A price elasticity value of -2.60 implies that a 1% decrease in price raises sales volume by 2.60%. If the absolute value of price elasticity is larger (smaller) than 1, consumers are price-sensitive (price-insensitive). Stated differently, higher absolute values of price elasticity imply that consumers react strongly to price changes.

2. Background on Dynamic Pricing and Personalized Pricing

Research distinguishes online pricing approaches between whether they focus on posted-prices or price-discovery strategies. Posted-prices refer to the classical situation in which retailers set prices. In contrast, price-discovery methods are common in auction formats such as eBay or in the form of name-your-own-price mechanisms (Spann and Skiera 2020). This chapter will focus on posted-prices due to their predominance in the retail industry, reflecting practitioners' understanding (Vogelsang 2020).

Regarding posted-prices, online pricing approaches can be classified into dynamic pricing and personalized pricing (Haws and Bearden 2006; Kannan and Kopalle 2001). Dynamic pricing refers to price changes over time that are the same for all consumers. Personalized pricing refers to different prices that consumers pay at the exact moment in time.

I will discuss dynamic pricing and personalized pricing in greater detail and review the key terms in Table 2. I also like to note that companies can combine the two approaches. For instance, a company could flexibly adjust its prices during the day (i.e., dynamic pricing) and at the same time offer personalized discounts to some consumers (i.e., a form of personalized pricing).

Table 2
Concepts of Dynamic Pricing and Personalized Pricing Defined

Pricing Approach	Characteristics
Dynamic Pricing	Frequent price changes (often during the day) which can be substantial (extensive price range)
Personalized Pricing	
<ul style="list-style-type: none"> ● Personalized Baseline Prices 	Different consumers see different prices in the same online shop
<ul style="list-style-type: none"> ● Personalized Coupons 	All consumers see the same (baseline) price in the same online shop. However, selected consumers receive special discounts.
<ul style="list-style-type: none"> ● Price Steering 	Consumers see different product results or the same products in a different order for the same search term. However, prices are the same.
<ul style="list-style-type: none"> ● Location-based Pricing 	Different consumers see different prices in the same online shop based on their geographical location

2.1. Dynamic Pricing

Two key dimensions can describe dynamic pricing: frequency and range of price changes. Thereby, **frequency** refers to the number of price changes over a specific period (e.g., one month). For instance, media reports demonstrate that the price of a digital camera on Amazon.com changed 275 times within three days. Another study counted three million price changes on Amazon in Germany during one day.

The **range** can refer to the range of individual price changes or the range of prices within a specific time window (e.g., highest and lowest price in one week). A systematic review of online prices revealed that individual price changes could be substantial. The median absolute size of a price change is 11% in the U.S. (Gorodnichenko, Sherenirov, and Talavera 2018). Besides, prices can differ broadly within a specific period. For instance, industry observers noted that a digital camera's price changed within hours by up to 240% at Amazon.com.

Figure 1
Dynamic Pricing

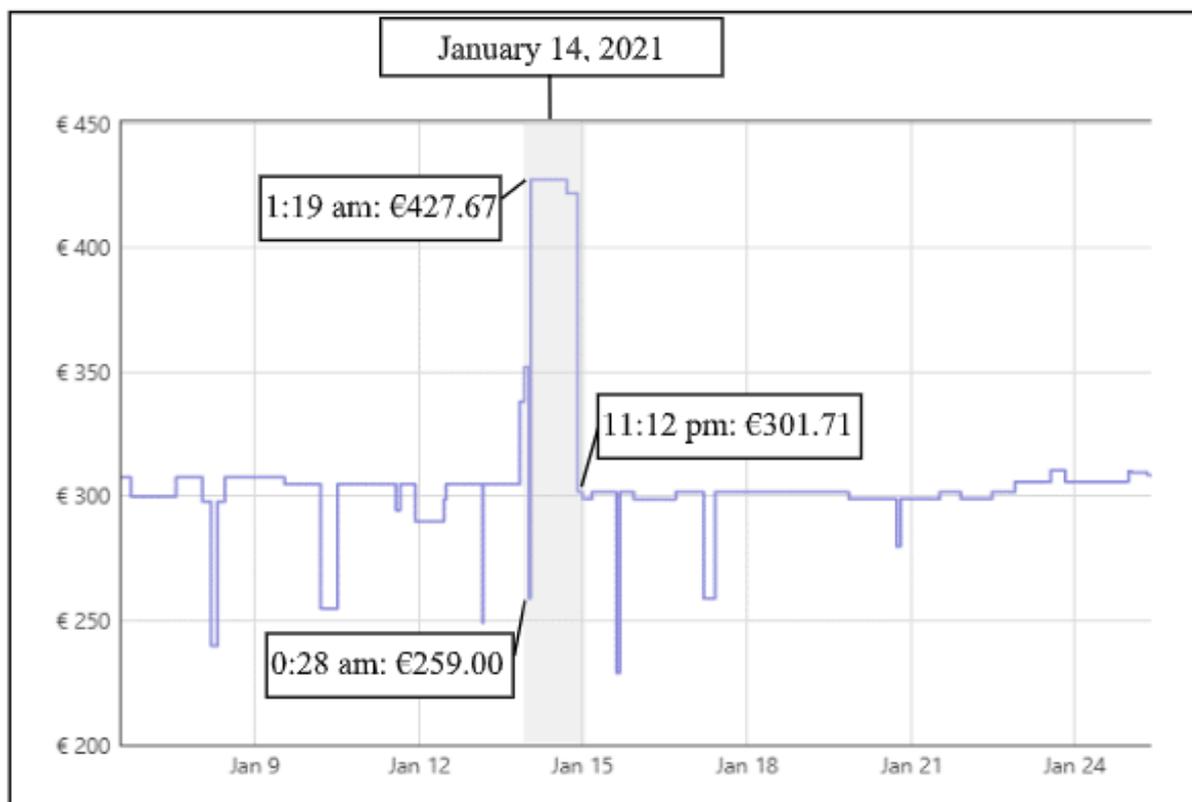


Figure 1: Dynamic Pricing of Samsung Galaxy Tablet (Tab A T510N 25, 54 cm, Tablet-PC (1.8 GHz Octa-Core, 3 GM RAM, 64 GB eMMC, Android 9.0, Black) on Amazon.de captured by keepa

Since dynamic prices are identical for consumers, price crawlers can visualize price changes. For example, consumers can download for free the price crawler plug-in keepa (<https://keepa.com/>), which tracks Amazon prices. Users will see the price developments for products on Amazon after they have installed the plug-in. Figure 1 demonstrates the evolution of prices for a Samsung Galaxy Table on Amazon.de. On January 24 (highlighted in grey), the price changed (frequency) around six times in a range from €259.00 (price at 0.28 am) to €427.67 (price at 1.19 am). Figure 1 illustrates why dynamic pricing can be compared to a slowed-down stock exchange.

2.2. Personalized Pricing

In contrast to dynamic pricing, personalized pricing requires some form of individualization. Companies can use the information that consumers leave behind as their "digital traces" to individualize prices. Specifically, companies can offer personalized baseline prices, personalized coupons, a personalized ranking of products on websites (referred to as price steering), or base prices on consumers' locations.

2.2.1. Personalized Baseline Prices

Retailers that employ personalized baseline prices show different prices to different consumers when consumers enter the website. Companies base those prices on some knowledge about the focal consumer's interests and behaviors.

Since retailers typically cannot observe a consumer's willingness-to-pay, retailers rely on indicators related to consumers' willingness-to-pay. Retailers may rely on information that consumers deliberately share with them. Retailers may use personal details that consumers enter when signing up in an online shop. Or, retailers use the information on consumers' willingness-to-pay that consumers reveal on "price wishlists" (Vogelsang 2020).

But retailers can also more "secretly" collect consumer information. Retailers can rely on cookie-data to acquire demographic information, track a consumer's browsing history, leverage information of the customer journey, consumer's operating system (e.g., Windows vs. iOS), or offer different prices based on whether consumers are using a smartphone, tablet, or PC. For instance, Mikians et al. (2012) observe that prices on Shoplet.com were on average 23% lower for users who came from a price comparison portal. Companies likely assume that consumers coming from price comparison portals are more price-sensitive (please note that such consumer tracking is likely problematic due to privacy regulations, see Section 5.2).

2.2.2. Personalized Coupons

Personalized prices, however, present only one way in which companies personalize prices for consumers. Targeting consumers with individualized coupons offers an alternative for personalized pricing. Customers receive individualized discounts based on their previous usage behavior. Companies implement such an approach, for example, through individualized newsletters, customer cards, or banners. For instance, the Dutch supermarket Albert Heijn regularly offers special discounts to consumers based on their loyalty card information.

Offering personalized coupons has several advantages over offering personalized prices. First, research indicates that consumers consider personalized coupons fairer than personalized prices (Weisstein, Monroe, and Kukar-Kinney 2013). A solution provider interviewed in the study by Vomberg, Lauer, and Weitkämper (2020) indicates the following:

S4: Online retailers don't work on price at all that often [...] because they are afraid that your perception of the price will be lower. That's why they primarily work through coupons. [...] And so online, as a retailer, you have the opportunity to say, "I'm going to keep the price level high and still make sure people convert by sprinkling in coupons."

Second and relatedly, personalized coupons (in contrast to personalized base prices) create the impression among consumers to realize a bargain. A drawback, however, is that there is initial evidence that consumers can become used to receiving personalized discounts. Consumers then perceive the absence of such coupons as an adverse event, comparable to a price increase (David et al. 2017).

2.2.3. Price Steering

Retailers can also employ price steering: Two consumers see different product results or the same products in a different order for the same search term. Search results presented earlier (e.g., on the first page) typically have a higher chance of being selected than products shown later. Thus, retailers can steer consumers towards buying higher-priced items.

For example, the online travel agency Orbitz Worldwide Inc. inferred that Apple Inc.'s Mac computer users would be willing to spend around 30% more a night on hotels. So Orbitz steered those consumers to costlier travel options: Mac users have seen more expensive options first, whereas non-Mac users have seen less costly alternatives (Mattioli 2012).

Retailers do not need only base price steering on the brand of the consumer's device. For example, retailers were reported to steer consumers to more expensive products based on whether those consumers visited in the past websites that carry expensive products or are geo-located to more wealthy postal codes (Iordanou et al. 2017). Experts also indicated that they engage in price steering in combination with personalized coupons. For instance, a retailer elaborated:

R5a: Cookies automatically detect it: you belong to the sports category, you use a Mac, which means you probably accept higher prices; therefore, I rank the products with a higher price first, and I give you 10% on the sports segment.

Price steering differs, at least, in two critical aspects from other forms of personalized pricing. First, with price steering, all consumers can, in principle, end up paying the same price. Thus, to contrast this practice from the former ones, price steering is also referred to as search discrimination (Mikians et al. 2012). Second, price steering does not focus on one focal product but a set of products.

2.2.4. Location-based Pricing

Location-based pricing represents a basic form of personalized pricing. It refers to any price differences of products sold by the same retailer simultaneously between geographical locations. Considering users' locations might be profitable due to shipping costs considerations. And companies can use users' locations to account for areas with more (compared to less) competing retailers. I separately discuss this form since industry experts indicated that they considered base prices on users' locations because they see profit-potential in location-based pricing (Vomberg, Lauer, and Weitkämper 2020).

Location-based pricing is a more common practice in offline markets. For instance, some drugstores in the U.S. charge different prices in their offline stores depending on their region (Cavallo 2017). However, there is also evidence of location-based pricing in online markets. Online retailers may rely on location information (e.g., IP addresses) to differ prices **between countries**. Studies observe online price differences between countries ranging from 21% (Mikians et al. 2012) up to 700% (Iordanou et al. 2017).

While studies observe location-based online price discrimination mostly between countries, there is also evidence of location-based pricing **within a country** (e.g., based on GPS data). Reports revealed that the office-retail supplier Staples.com displayed different prices to different people after estimating their locations. Staples.com might have also used information on the person's distance to the next competing offline store for setting the price (Valentino-DeVries, Singer-Vine, and Soltani 2012).

However, besides such initial evidence, industry experts note that location-based pricing is not frequently used within a country in online markets for offering different baseline prices or discounts for two reasons (Vomberg, Lauer, and Weitkämper 2020). First, regulations (such as from the German Federal Ministry of Justice and Consumer Protection) stand in the way of this approach. Second, experts also mentioned technological problems: in their opinion, GPS data would currently not be sufficiently accurate for location-based pricing.

Finally, findings from research question the usefulness of location-based pricing. The academic literature, in general, demonstrates that differentiation based on demographics such as location offers little value (Rossi, McCulloch, and Allenby 1996; Shiller 2014).

2.3. How Common Are Dynamic Pricing and Personalized Pricing in Business Practice?

After discussing the different forms of online pricing, a focal question is likely, how widespread are the different approaches in company practice. Naturally, with rapidly changing prices, it is challenging for researchers to attribute observed price differences to either form in practice. However, there are systematic investigations that largely attenuate such concerns.

In general, those studies hardly find evidence of personalized (baseline) prices (Hannak et al. 2014; Hupperich et al. 2018; Iordanou et al. 2017). Studies provide evidence on location-based pricing; however, it still qualifies it as a niche phenomenon (Hupperich et al. 2018; Iordanou et al. 2017). Most dominantly, retailers rely on price steering (Hannak et al. 2014). Thus, although personalized pricing received a lot of media attention and stimulated consumer outrage, there is hardly any evidence that many companies offer different baseline prices to large extents.

In contrast, there is much evidence that retailers employ dynamic pricing. Verbraucherzentrale Brandenburg (2020) tracked price developments of different products over five weeks for selected retailers. Results show that dynamic pricing is standard in various industries. For instance, the consumer electronics companies Media Markt and Conrad Electronic were observed to dynamically price 65% and 36% of their products, respectively. Similarly, dynamic pricing is observed among mail-order pharmacies such as Sanicare (87%) and

DocMorris (59%), automotive accessory companies such as Auto-Teile-Unger (41%) and Tirendo (71%), and mail-order companies such as Otto (34%) and Zalando (49%).

Thus, the available evidence indicates that dynamic pricing occurs more frequently than personalized pricing in online markets—at least, as compared to personalized pricing in the form of different baseline prices. Expert opinions support this assessment.

S8: So, for Europe, individual pricing is the absolute exception. That has to be said quite clearly. The reason for this is a combination of technical limitations and a deliberate shying away from possible adverse effects.

I expect that this trend will continue in the future. On the one hand, dynamic pricing will become more critical due to competitive pressures. On the other hand, ongoing privacy regulations (Section 5.2) presumably lower the speed at which personalized pricing spreads. Also, market developments such as Internet browsers (e.g., Microsoft Firefox) that disable cookies will restrict companies' personalized pricing opportunities. Given its prevalence, I will focus predominantly on how companies can implement dynamic pricing in the following.

3. Designing Dynamic Pricing Approaches

The previous paragraphs demonstrated that companies increasingly rely on dynamic pricing. While prior studies suggest that dynamic pricing increases profits, studies also show that the effect of dynamic pricing on profits depends on how companies implement dynamic pricing. In the following, I will discuss important decisions that retailers need to make. Specifically, I will provide guidance on IT implementation, selecting determinants for dynamic pricing, and product portfolio considerations. Table 3 summarizes the key issues.

Table 3
Key Decision Areas, Options, and Factors for Dynamic Pricing

Key Decision Areas	Key Decision Options and Factors
1. IT Implementation <i>"Which software should be used to implement dynamic pricing?"</i>	<ul style="list-style-type: none"> ● Repricing software: meeting/beating competitor prices ● Sophisticated pricing tools: Repricing functions + additional options (e.g., market experiments, inventory considerations)
2. Determinants for Dynamic Pricing <i>"Which determinants should inform dynamic pricing?"</i>	<p>Important (not necessarily commonly used)</p> <ul style="list-style-type: none"> ● Competitor prices ● Consumer price elasticity ● Inventory level ● Strategic considerations (e.g., service levels) <p>Less important</p> <ul style="list-style-type: none"> ● Weather conditions ● Time of the day/day of the week

<p>3. Product Portfolio Considerations</p> <p><i>"When are competitor prices more important for the dynamic pricing approach?"</i></p>	<p>Competitor prices more critical for</p> <ul style="list-style-type: none"> ● Highly comparable products ● National brands ● Non-luxury brands ● Key-value items
<p><i>"Which product portfolio aspects need to be considered?"</i></p>	<ul style="list-style-type: none"> ● Price alignment between product variants ● Role of the product (key-value item vs. no key-value item) ● Product availability in different channels

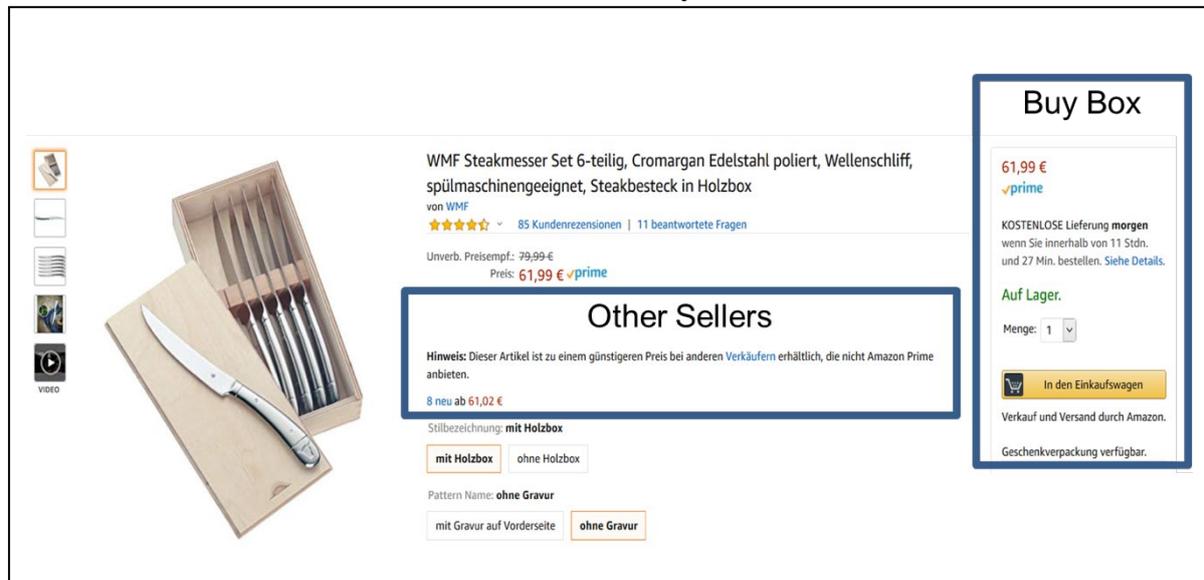
3.1. IT implementation

In general, the implementation of dynamic pricing requires IT solutions. Companies can either rely on self-developed algorithms or use IT solutions that are offered on the market. Expert-interviews revealed that companies most dominantly rely on offered IT solutions since their development would require extensive efforts (e.g., programming and maintenance) (Vomberg, Lauer, and Weitkämper 2020). I classify externally developed solutions into Amazon repricing software, general repricing software, and more sophisticated pricing tools.

Amazon repricing software focuses on pricing on Amazon. Companies rely on this software to "win" the so-called buy box. In many instances, multiple companies sell the same product on Amazon. In these cases, a proprietary Amazon algorithm determines whose company's product is visible to consumers in the buy box. Consumers can find offers from other companies on a different webpage. Winning the buy box is vital for companies; experts from Germany (Vomberg, Weitkämper, and Lauer 2020) and international observations (Chen, Mislove, and Wilson 2016) indicate that 82% of the purchases made on Amazon result from the buy box. Thus, retailers who do not win the buy box only close a sale in 18% of the cases.

Amazon repricing software lowers the retailer's price automatically until its price is below the competitor's price or until it reaches a pre-determined lower bound for the price. For the sake of completeness, I want to emphasize that the Amazon algorithm considers additional aspects such as shipping options and speed of delivery (Chen, Mislove, and Wilson 2016 investigate the algorithm in greater detail) to determine which offer will appear in the buy box. Therefore, as Figure 2 demonstrates, it is not necessarily the case that the company with the lowest price appears in the buy box. However, companies widely use Amazon repricing software since the price is typically the criterion that companies can influence most quickly.

Figure 2
Illustration of the buy box



General repricing software operates in the same manner as Amazon repricing software does. However, general repricing software also considers different prices, not only those offered on Amazon. For instance, the software scraps competitor prices from price comparison tools such as Idealo or Google Shopping. A crucial decision that retailers need to make is to specify the relevant competitors and which products or product categories prices should be adjusted. Since there is no need to win the buy box on retailers' online shops, retailers can use the information to fully automate prices (just like selling on Amazon) or use the acquired knowledge to inform their (manual) pricing.

Finally, solution providers also offer more **sophisticated pricing tools**. In contrast to repricing tools which focus on competitor prices as the key determinant for dynamic pricing, sophisticated pricing tools consider additional information. For instance, those tools consider internal data such as inventory levels or compute optimal prices based on machine learning algorithms. Such sophisticated tools lower prices to beat competitors and conduct market experiments; systems will randomly raise prices to see and learn competitor and customer reactions (Mims 2017).

3.2. Determinants for dynamic pricing

Overall, the effectiveness of the dynamic pricing approach depends on which determinants companies include in their algorithm. I classify these determinants into market-related, customer-related, and company-related factors.

3.2.1. Market-related factors

Discussions with practitioners revealed that companies most dominantly rely on competitor prices to inform their dynamic pricing strategy. Experts interviews revealed that competitor prices are of focal importance, particularly in the online domain, since customers can easily compare prices on price comparison portals. Besides, tracking competitor prices is easy to achieve in the online domain (e.g., obtained from repricing tools).

S2: Experience shows that online retailers are exposed to such high competitive pressure that they have no choice but to respond to their competitors' prices.

While research demonstrates the need to consider competitor prices, research also indicates that companies should incorporate consumer price sensitivities in their algorithms to enhance their returns from dynamic prices (Fisher, Gallino, and Li 2018). In this regard, media reports discuss the day's time and the weather as indicators or drivers of consumers' price sensitivity (Mersch and Merx 2015). This idea already dates back to the 1990s. The Coca-Cola Company experimented with raising prices in vending machines on hot days (Nicas 2015).

However, whether companies should consider such aspects likely depends on the environment in which they strive to sell their product. The time of the day or weather conditions might affect the prices of companies selling on online marketplaces. For instance, when more shoppers are on online market places on Sunday evenings than on Monday mornings, it is imperative to win the buy box. However, experts indicated that time of the day effects or weather effects are less significant for companies that do not sell on marketplaces. While both likely impact the number of consumers in their online shops, these factors are unlikely to impact shoppers' price sensitivities (Vomberg, Lauer, and Weitkämper 2020).

3.2.2. Customer-related factors

Rather than relying on indicators such as the weather or time of the day to infer consumers' price sensitivities, companies should directly incorporate consumers' price responses (BenMark et al. 2017). Companies could conduct randomized market-experiments to learn how much consumers will buy at different price points (Fisher, Gallino, and Li 2018). Alternatively, solution providers indicated that they infer customers' price sensitivities from real-time click and real-time transaction data (Vomberg, Lauer, and Weitkämper 2020). For instance, if an increasing number of customers clicks on the same article, the focal article's price might increase. This approach does not represent personalized pricing because it relies on aggregated customer data and increases prices for all customers.

3.2.3. Company-related factors

Retailers naturally also need to align their dynamic pricing approach with their internal goals. Companies can consider purchase prices and their inventory levels. For instance, fashion retailers may dynamically vary the prices of clothes during the season to avoid heavy discounts during end-of-season sales. Finally, companies can also consider the offered service level. Experts, for instance, indicate that consumers likely have a willingness-to-pay for higher service levels (Vomberg, Lauer, and Weitkämper 2020).

3.3. Product Portfolio Considerations

Moreover, companies need to decide which products they focus on for dynamic pricing and relatedly if they rely on different price-setting determinants. This decision depends on the comparability of the products, the brand, and whether the product constitutes a key-value item.

3.3.1. Comparability

The ease with which consumers can obtain prices for different products determines how competitor prices should inform the dynamic pricing approach. Products are typically easy to compare if they can be found on a search engine by typing in the product's name or the unique electronic article number (EAN). Among the products with a high degree of comparability are consumer electronics or national brands. Product categories with a low degree of comparability are, e.g., unique fashion items, furniture, or private brand products.

To lower the comparability between products, some news reports indicate that companies use different offline and online EANs to obfuscate price differences and prevent comparison. Research, however, does not find evidence that this technique is broadly applied (Cavallo 2017).

3.3.2. Brand

Dynamic pricing likely differs between private-label brands, national brands, and luxury brands. Private-label brands are developed and produced directly by a retailer or manufacturer and generally sold exclusively by that retailer. Those brands do not compete with other retailers, and consumers cannot search for them on price comparison portals. As a consequence, competitor prices are available for private-label brands. Private-label brands can thus optimize their pricing along with consumer price sensitivities and internal considerations. For instance, Amazon is reported to develop their private-label versions of competing products to reduce competitive pressures: e.g., while the price of Duracell AAA batteries fluctuates, the price of Amazon's private-label brand of AAA batteries is stable (Mims 2017).

In contrast, national brands often have easy-to-search names (e.g., Nike Airmax). Thus, they are highly comparable and therefore subject to intensive price pressure. Additionally, national brands are essential from a retailer's perspective, as they pull customers into the shop. For those national brands, typically, competitor prices should be considered.

Finally, experts claimed that luxury brands are less susceptible to price and therefore also competitor prices are less considered (Vomberg, Lauer, and Weitkämper 2020). For instance, a fashion retail chain manager explained that the manager excludes premium brands from any type of dynamic pricing. According to the manager, for luxury products, it is not necessary to compete on prices. Frequent price changes may even negatively impact the brand's high-quality image.

3.3.3. Key-value items

The dynamic pricing approach's design needs to consider individual products and their prices and the complete product portfolio, and the relative prices within the portfolio. For instance, retailers need to ensure that the pricing algorithm does not run counter to strategic pricing decisions. For example, prices of product variants (e.g., product in different colors) may need to be the same, and relative prices need to align (e.g., paint cans of larger volume cost more than little ones) (Natter et al. 2007).

Another important consideration is the role of key-value items (sometimes referred to as product heroes). In online channels, customers typically first choose which product to buy and then select the store that offers the best price. However, it is common for offline shoppers to purchase multiple products in one shopping trip. Consumers choose a store and then decide which products to buy. Key-value items pull customers into the store or initiate a purchase. Therefore, particularly for multichannel companies, this decision is essential.

For key-value items, retailers need to rely on competitive prices. Besides, key-value items drive customers' perceptions of the overall price image of the assortment. Interviews indicated that even retailers that only cautiously implement dynamic pricing systematically rely on competitive prices for key-value items. Likewise, most solution providers offer a particular module for key-value items, which calculates optimal prices more frequently than other products (e.g., BenMark 2017).

4. Challenges

Finally, managers need to overcome focal internal and external challenges when implementing their pricing approach. External challenges can result from adverse consumer reactions and privacy regulations. Internal challenges can result from the company's IT infrastructure, the simultaneous reliance on on- and offline channels, and cultural hurdles. Table 4 summarizes the discussion.

Table 4
Challenges to Dynamic Pricing and Personalized Pricing,
Problem Description, and Potential Remedies

Challenge	Description	Remedies
External Challenges		
#1 Adverse Consumer Reactions	<ul style="list-style-type: none"> ● Consumers consider dynamic pricing and personalized pricing unfair 	<ul style="list-style-type: none"> ● Complaint management approaches
#2 Privacy Regulations	<ul style="list-style-type: none"> ● Regulations restrict usage of data needed for pricing approaches 	<ul style="list-style-type: none"> ● Focus on dynamic pricing ● Obtain consumer consent
Internal Challenges		
#3 IT Implementation	<ul style="list-style-type: none"> ● Companies lack the necessary IT infrastructure 	<ul style="list-style-type: none"> ● Rely on an externally developed software
#4 Multichannel Dynamic Pricing Dilemma	<ul style="list-style-type: none"> ● Company may end up with different prices in on- and offline channels 	<ul style="list-style-type: none"> ● Restrict dynamic pricing to exclusive online assortment ● Dynamic pricing only for key-value items ● Lower frequency of price changes

#5 Cultural Changes	<ul style="list-style-type: none"> ● Internal resistance to automate pricing decisions 	<ul style="list-style-type: none"> ● Align dynamic pricing algorithm with incentive schemes ● Involve pricing managers in algorithm specifications ● Step-wise rollout, followed by performance evaluations
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4.1. Challenge #1: Adverse Consumer Reactions

A focal consideration is how consumers react to dynamic pricing. In this regard, the literature demonstrates that consumers perceive both dynamic pricing and personalized pricing as unfair. However, consumers react more negatively towards personalized pricing (Haws and Bearden 2006). Personalized pricing may lower the consumer's trust in the retailer (e.g., Gabarino and Lee 2003) and a consumer's repurchase intentions (Gabarino and Maxwell 2010). Importantly, not only price-disadvantaged consumers react negatively. Consumers who realize a better price than other consumers also tend to display adverse reactions (e.g., guilt), particularly if they like the consumers who paid higher prices (Gelbrich 2011).

To avoid negative consequences, retailers try to resolve these tensions provoked by consumer evaluation by concealing their pricing approach. While not all consumers are currently aware of dynamic pricing, I expect that concealing is unlikely to be a long-lasting strategy. Transparency of dynamic pricing and personalized pricing is likely to increase due to media reports exposing these techniques to broad audiences. Thus, retailers may establish complaint management approaches. Retailers could offer special discounts for consumers who note differences in prices.

4.2. Challenge #2: Privacy Regulations

Recent regulations such as the General Data Protection Regulation (GDPR enacted in 2018) or the California Consumer Privacy Act (CCPA enacted in 2020) restrict consumer/user data usage and require companies to disclose all of their data processing activities. Besides, in many cases (e.g., GDPR), companies are only allowed to process consumer data after consumers gave their consent. Notably, any information that directly or indirectly relates to a person qualifies as personal data, or stated differently, any identifier connected to an individual qualifies as personal data. Instead of only focusing on the consumers' names and addresses according to privacy regulations, IP addresses or cookie identifiers also qualify as personal data (Bleier, Goldfarb, and Tucker 2020).

Such regulations affect dynamic pricing to a lesser extent, as dynamic pricing typically relies on competitor-related and company-internal information and only analyzes aggregate consumer data². However, personalized pricing requires that companies transparently communicate to consumers that they use their data for personalized pricing and request consumer consent

² For the sake of completeness, I emphasize that also the analysis of aggregate data can conflict with privacy regulations. If companies aggregate individual personal data, this requires either that consumers gave their consent or that there is a legitimate interest in processing the data.

(Spann and Skiera 2020). Experts raise severe doubts that consumers will provide their consent for personalized pricing (Borgesius and Poort 2017).

Importantly, GDPR also rules out that retailers process certain kinds of data (also referred to as "sensitive data") in general. Thus, companies are not allowed to perform personalized pricing on such sensitive data. Sensitive data are "personal data revealing racial or ethnic origin, political opinions, religious beliefs, or trade union membership, and the processing of genetic data, biometric data for the purpose of uniquely identifying a natural person, data concerning health or data concerning a natural person's sex life or sexual orientation)" (Article 9(1) GDPR).

4.3. Challenge #3: IT Implementation

Technological developments such as the availability of real-time customer and competitor data and the potential automation of pricing decisions have enabled dynamic pricing. At the same time, technological hurdles represent a reason why companies shy away from dynamic pricing. Typically, small- and medium-sized companies do not have sufficiently strong IT capabilities to develop a dynamic pricing solution. However, those companies can still rely on external software solutions.

Technological hurdles are even more pressing in the context of personalized pricing. The experts stated that customer-specific prices would require individual landing pages, which would mean a substantial IT outlay. Furthermore, identifying customers via different end devices (e.g., laptop, smartphone) would represent a hurdle. Customers would notice different prices when changing the end device. However, the experts agree that large and innovative online stores with sufficient IT capability can overcome these problems (Vomberg, Lauer, and Weitkämper 2020).

S4: "Everyone gets their own price." Retailers can't do that at all. [...] Because that would mean that every person gets their own landing page. That's a) a server power that most stores can't even afford, and b) a considerable effort.

4.4. Challenge #4: Multichannel Dynamic Pricing Dilemma

Notably, for multichannel retailers (i.e., simultaneous usage of online and offline channels), dynamic pricing can constitute a crucial challenge. Multichannel companies need to make two decisions. First, they need to decide whether they aim for price consistency or differentiation between online and offline channels. Second, they need to determine how they implement dynamic pricing.

Figure 3
Illustration of Price Differentiation
between the Online and Offline Channels of a Multichannel Retailer

The screenshot displays a product page for a Lenovo server. On the left is a large image of the server tower. To its right, technical details are listed: Best.-Nr.: 1231120-62, Tele-Nr.: 57330358, EAN: 4016138925401, and the Lenovo logo with a 5-star rating. The main content area is divided into two columns. The left column, titled 'Online Price', shows a price of € 269,00 (including VAT and shipping) with a 'Jetzt prüfen' button. The right column, titled 'Offline Price', shows a price of € 275,00 (including VAT and shipping) with a 'Lieferung in Filiale' button. Below these, delivery information is provided: 'Lieferung in 2 bis 3 Tagen' for the online channel and 'Lieferung in 3 bis 4 Tagen' for the offline channel. A 'Finanzierung' option is also visible at the bottom.

First, the consumer electronics company Conrad Electronic serves as an example of a company that transparently differentiated prices between their online and offline channels. Conrad Electronic communicated a store price and a lower online price on its website for some time (Figure 3).

In contrast to the example above, a systematic large-scale empirical investigation of online and offline prices from multichannel retailers from different countries revealed that multichannel retailers' predominantly (72% of the cases) set the same price in their online and offline channels (Cavallo 2017). But there are differences between industries: drugstores and office-product retailers have the lowest share of identical prices, with 38 percent and 25 percent, respectively, while for consumer electronics and clothing retailers, these numbers rise to 83 percent and 92 percent, respectively.

Overall, results indicate that companies set prices equally between channels. I am only aware of one study that systematically investigates sales volume implications and consumer reactions to online-offline-price differentiation (Homburg, Lauer, and Vomberg 2019). This study shows that, in general, companies can hardly realize offline price premiums. Only for high-priced items and take-away items, consumers accept higher prices. Consumers consider buying high-priced items risky and most likely have more confidence in offline channels. For take-away items, consumers are typically not price-sensitive. However, in between these two extremes, the results show no potential for offline price premiums.

Second, although companies typically strive for a price-consistency strategy, competitive online pressures can force retailers to employ dynamic pricing and accept temporary price differences between online and offline channels.

Companies can resolve these tensions in different ways. Companies that do not sell all products in both their online and offline channels can focus on dynamic pricing only for the online

channel and/or adopt dynamic pricing only for key-value items. Also, since the frequency of price changes is typically lower in offline channels, companies may reduce the frequency of price changes in the online channels.

However, I also want to add that some multichannel retailers state that potential threats from multichannel dynamic pricing outweigh its potential gains and, therefore, abolished dynamic pricing.

R6: We just discontinued the topic of dynamic pricing last week. [...] The fact is that dynamic pricing offline, and online is not possible as a multichannel provider. That means Dynamic Pricing can only work well for pure-online players! That's actually what it's intended for, and it's a pretty perfect tool for that!

4.5. Challenge #5: Cultural Changes

The implementation of dynamic pricing requires that companies delegate pricing decisions for which humans have been in charge to algorithms. While pricing managers or the procurement department traditionally set prices, using an automated dynamic pricing algorithm implies a loss of control of former pricing managers. Naturally, this requires that many companies go through significant cultural changes. One retailer notes the following:

R3: It's not just a question of technology ..., but also has to do with change and cultural change... That requires that you become a bit more agile... So it's a question of mentality. That's also what dynamic pricing is about - it's part of the big picture, the extent to which a company is willing to adapt and radically introduce processes and changes in the company. So Dynamic Pricing is not just software [...]; it's usually a fundamental change in the way you've been doing things.

Implementing cultural changes requires that companies align formal and informal elements (Vomberg, Homburg, and Gwinner 2020). Regarding formal elements, managers, for example, need to make sure that dynamic pricing algorithms align with incentive schemes. Natter et al. (2007) document a case in which resistance to dynamic pricing was spurred since the dynamic pricing algorithm maximized profits, while sales managers' variable compensation depended on sales volume targets.

Regarding informal elements, managers need to create a cultural mindset that is open to pricing automation. This likely represents a challenging task since, in general, people exhibit an aversion to algorithms. Such an aversion can present a particular concern if managers perceive the dynamic pricing algorithm as a "black box," that is if managers cannot understand how the algorithm works and why it suggests a focal price. In such a situation, it becomes likely that managers will reject the algorithm entirely, or at least, not trust its results.

To lower pricing managers' aversion, managers should involve them in selecting and configuring the dynamic pricing algorithm. Research documents that such involvement can lower aversion to algorithms (Dietvorst, Simmons, and Massey 2016).

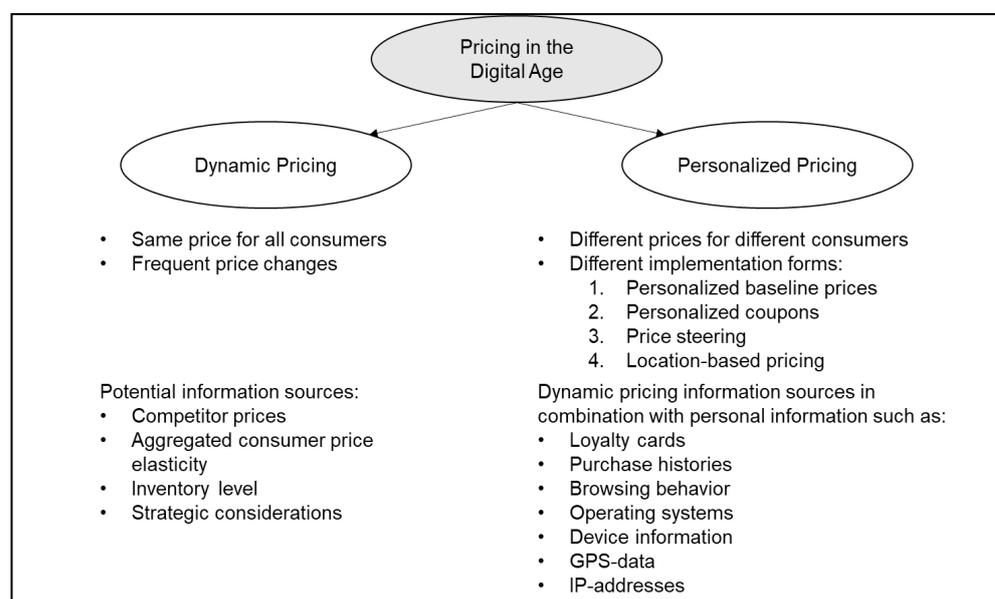
Moreover, companies should demonstrate to pricing managers the need and returns for dynamic pricing. For instance, demonstrating volatility in competitor prices may overcome resistance. Also, managers could communicate potential returns to automated pricing (e.g., Karlinsky-Shichor and Netzer [2019] show that a combination of automatic pricing and human judgment can result in increased performance). Managers could roll out dynamic pricing for a subset of products and jointly evaluate the effectiveness with pricing managers (Natter et al. 2007).

5. Concluding Remarks

Pricing decisions make a significant contribution to corporate success (Homburg et al. 2015). The ongoing digitalization has increased access for firms to information on their competitors and customers and allows companies to automate their pricing. These developments have resulted in two novel pricing approaches: dynamic pricing and personalized pricing (Figure 4 summarizes the discussion). While those pricing approaches are typically associated with large online retailers, small- and medium-sized companies can equally apply them. Industry experts expect that dynamic pricing, in general, will become the norm in online markets.

Dynamic pricing can contribute to company success. However, to unfold its full profit-creating potential, retailers need to design their dynamic pricing approach carefully. Besides, retailers need to overcome challenges when implementing a dynamic pricing approach. Based on the current state of academic research and interviews with managers, I discussed focal decisions managers need to make on how to design their dynamic pricing approach. In addition, I discussed how retailers could address focal implementation challenges. Overall this chapter guides managers to unlock hidden profits with their dynamic pricing approach.

Figure 4
Summarizing overview of Dynamic and Personalized Pricing



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