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# DYNAMIC PRICING IN MARKETING

*Forming effective marketing communications with the target audience in the digital environment involves implementing a modern and flexible pricing system that considers the dynamics of changes in a set of factors. A hypothesis has been formulated that dynamic pricing based on machine learning algorithms allows businesses to achieve optimal demand for goods and services of companies, and also helps to ensure the loyalty of consumers to the brands in the long term. Conducting the research, general scientific methods of analysis and synthesis were used to characterize the main strategies of dynamic pricing used in marketing; empirical methods, graphical representation, and system-structural analysis. The main pricing strategies used by companies to stimulate demand for goods and services are presented. The effectiveness of using dynamic pricing in various areas of economic activity is proven, and international companies that successfully use the presented approaches are also presented. The main strategies of dynamic pricing are disclosed, which are used following the specifics of the company's activities, the characteristics of the target audience, and product characteristics.*

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# ДИНАМІЧНЕ ЦІНОУТВОРЕННЯ У МАРКЕТИНГУ

*Формування ефективних маркетингових комунікацій з цільовою аудиторією у цифровому середовищі передбачає впровадження сучасної та гнучкої системи ціноутворення, що враховує динамічність зміни комплексу факторів. Сформульовано гіпотезу, що динамічне ціноутворення на основі алгоритмів машинного навчання дозволяє підприємствам досягати оптимального попиту на товари та послуги компаній, а також допомагає забезпечити лояльність споживачів до брендів у довгостроковій перспективі. У ході дослідження застосовано загальнонаукові методи аналізу й синтезу для опису ключових стратегій динамічного ціноутворення, що використовуються в маркетинговій діяльності. Також використано емпіричні підходи, графічні методи подання інформації та системно-структурний аналіз. Розглянуто основні цінові стратегії, які компанії застосовують для стимулювання попиту на товари та послуги. Показано ефективність динамічного ціноутворення в різних галузях економіки, а також наведено приклади міжнародних компаній, які успішно впроваджують ці підходи. Розкрито основні стратегії динамічного ціноутворення, що використовуються відповідно до специфіки діяльності компанії, особливостей цільової*

*The main advantages of using dynamic pricing in e-commerce are presented. The prospects for the development of the consumer electronics market are proven, and the dynamics of the growth of this market capacity during 2023–2034 are presented. Basic machine learning algorithms are used to build dynamic pricing models for popular smartphone models in three price segments in Ukraine in 2025.*

*Keywords:* dynamic pricing, marketing, machine learning, gradient boosting model, consumer electronics, smartphones, target audience.

*аудиторії та характеристик продукції. Наведено основні переваги використання динамічного ціноутворення в електронній комерції. Доведено перспективність розвитку ринку споживчої електроніки та представлено динаміку зростання ємності ринку в період 2023–2034 рр. Використано основні алгоритми машинного навчання для побудови моделей динамічного ціноутворення для популярних моделей смартфонів у трьох цінових сегментах в Україні у 2025 р.*

*Ключові слова:* динамічне ціноутворення, маркетинг, машинне навчання, модель градієнтного бустингу, споживча електроніка, смартфони, цільова аудиторія.

**JEL Classification:** D12, D40, L11, M31, O33.

## Introduction

The high level of competition in many markets in the context of digitalization leads to the need to transform companies' communication strategies and intensify the integration of advanced approaches into marketing elements. Target audience orientation and comprehensive influence through the use of modern marketing tools allows companies to build close and long-term communications. Interaction with customers occurs in offline and online environments, but the gradual increase in the number of Internet users encourages companies to actively reorient themselves to digital technologies.

The global network should be considered as a source of big data, since companies have the opportunity to collect relevant information from various sources. First of all, web analytics is used to accumulate information about the functioning of the company's web resources (sites, social media pages, etc.). Along with this, it is possible to study the features of certain markets functioning, main competitors, and user behavior based on public web resources and paid services, as well as by collecting information through API, parsing, etc.

Modern machine learning algorithms allow processing big data and optimizing business processes. Thanks to comprehensive analytics based on powerful mathematical algorithms, companies can optimize marketing strategies and achieve long-term economic efficiency. An important element of marketing is pricing policy, which allows influencing users through the cost characteristics of goods and services. Optimization of pricing to stimulate demand for goods and services is an important area of marketing activity. The digital environment, combined with modern machine learning algorithms and the prospect of intensifying the use of artificial intelligence, allows companies to gradually move to dynamic pricing and ensure a high level of personalization. Adapting prices to a specific client in certain spatial and temporal conditions is an effective approach in the process of interacting with representatives of generations Y, Z, and Alpha, who actively use the digital environment daily and consume a significant number of goods and services.

Scientific research indicates significant prospects for the application of dynamic pricing approaches in marketing. Considerable attention is focused on the integration of modern machine learning algorithms by companies, which, based on big data, allow determining the optimal price for a specific client according to the action of a complex of factors. The problem of introducing dynamic pricing into the marketing strategies of companies is highlighted in the works of the following scientists: Ban and Keskin (2021), Shah et al. (2021), Bastani et al. (2022), Nunan and Di Domenico (2022), Kastius and Schlosser (2022), Shin et al. (2023), Basal et al. (2024), Suresh et al. (2025), Chenavaz and Dimitrov (2025). Scientists are exploring the possibilities of implementing various machine learning algorithms when implementing dynamic pricing models in marketing. Applied problems of big data processing are being solved, primarily in the field of e-commerce, to form effective personalized communications with customers and stimulate sales. Along with this, there is a need to determine the optimal parameters for mathematical algorithms taking into account the characteristics of the target audience, since in the digital environment users actively interact with each other and may perceive personalized dynamic pricing in certain cases as discrimination based on various social, psychological, demographic and economic characteristics. Given the development of machine learning and the active introduction of artificial intelligence, it is advisable to focus on finding optimal approaches to big data processing and building dynamic pricing models that will contribute to achieving the maximum possible economic results.

The aim of the research is to substantiate the directions of integration of dynamic pricing based on machine learning algorithms into marketing strategies of companies in the digital environment.

Following the aim, a hypothesis has been formulated that dynamic pricing based on machine learning algorithms allows businesses to achieve optimal demand for goods and services of companies and also helps to ensure the loyalty of consumers to the brands in the long term. The presence of various approaches to processing big data and the implementation of complex mathematical models through cloud computing allows for the quick implementation of dynamic pricing approaches. Due to the possibility of constant improvement based on new data, the used machine learning algorithms allow for a constant increase in the effectiveness of the implementation of marketing strategies, primarily in the digital environment.

The presented article involves the use of the following scientific research methods: analysis and synthesis to characterize the main dynamic pricing strategies used in marketing; empirical methods, graphical representtation, and system-structural analysis.

The concept of dynamic pricing based on machine learning and artificial intelligence algorithms has significant prospects for further development and implementation in all types of economic activity. However, there are risks regarding the ethics of using users' personal data in certain conditions, as well as manifestations of unethical pricing in relation to certain categories of consumers.

The three sections of the article present the basic pricing strategies used by companies to promote products at the national and international levels. The features of implementing dynamic pricing based on big data, which can be accumulated permanently in the digital environment, are revealed. The main dynamic pricing strategies are presented, which allow forming optimal prices based on a set of specific factors operating in specific spatio-temporal conditions. An analysis of the dynamics of the consumer electronics market during 2023-2034 is conducted, and the feasibility of using smartphone prices in building dynamic pricing models is substantiated. In the process of research, dynamic series with prices for smartphones from the premium segment were used. The results of price modeling based on machine learning algorithms are presented to achieve the goals of dynamic pricing in marketing.

## 1. Digital marketing and artificial intelligence: basic concepts

In the conditions of war in Ukraine, companies are faced with the question of finding a balance between prices and ensuring the value of products. The decline in living standards, combined with the increase in the price of exports and domestic products, requires companies to optimize pricing processes to ensure the loyalty of the target audience. Finding a balance between product prices and the solvent demand of citizens in Ukraine is an important element of the marketing strategy of any company and involves the use of scientifically based approaches. The formed pricing policy must ensure the competitiveness of the company, an economically justified level of product sales, and a positive attitude of customers in the long term. The formation of an effective strategy involves adhering to the following principles:

*Consumer value*. Customers form their attitude towards a particular product or service following a set of factors, assessing the price according to their judgments about the level of utility of the corresponding product. A comprehensive analysis of the market over a certain period and taking into account the wishes of the target audience allows identifying the optimal price for a specific product.

*Competitive environment*. A comprehensive analysis of the main market participants and price monitoring allows optimizing the company's pricing strategy. By identifying positions compared to competitors, it is possible to form the company's price, which will help attract the maximum number of customers. The company can use dumping pricing, focus on average prices in the market, or set higher prices due to increased demand.

*Product positioning*. When forming demand for products, positioning plays an important role, as it is related to the pricing strategy and involves a psychological impact on consumers. Premium goods and services are characterized by a high price, which, according to the expectations of the target audience, is explained by elitism and compliance with quality

standards. In conditions of war and economic instability, high demand is noted for goods and services in the economy segment, as consumers with low incomes focus on affordable price offers.

*Pricing strategies*. The high level of competition in the conditions of globalization and interaction with users in the offline and online environment involves the choice of the optimal strategy. At the current stage of development, the main pricing strategies are included (*Figure 1*).

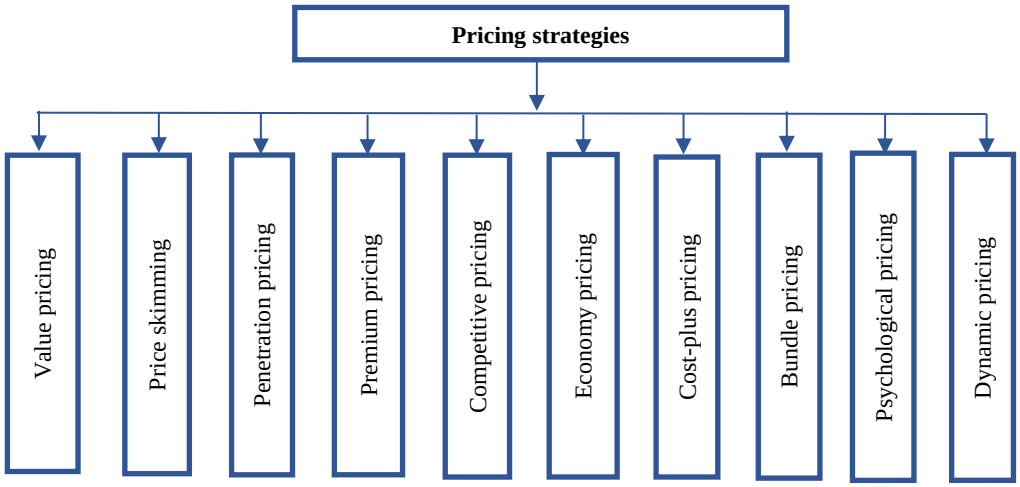


Figure 1. Modern pricing strategies

*Source*: compiled and supplemented by the authors from (Keenan, 2025, March 10).

*Value pricing*. The key role in price formation is played by the identification of the value of a particular product by the client and their willingness to spend certain funds. The cost of the product and the market situation act as additional factors in the pricing process, but the emotional component is also important, thanks to which customers form their subjective attitude to goods and services. The presented strategy is appropriate for use by customers who are interested in purchasing goods with high-quality characteristics. To maximize profits, a comprehensive study of the target audience and adaptation of the marketing strategy to the urgent needs of customers are necessary.

*Price skimming*. Popular brands can launch products on the market, stimulating increased demand among the target audience. Some buyers try to purchase products at early stages at inflated prices in order to demonstrate their high status among friends and acquaintances. Using the presented pricing strategy allows companies to make significant profits at the initial stage of product sales. In conditions of high competition, the company has the opportunity to apply price skimming for a short period, since competitors can quickly launch similar products at lower prices.

*Penetration pricing*. When a company launches a new product on the market, which is accompanied by insufficient awareness of the target

audience and low demand, it is advisable to set a low initial price. The presented strategy involves providing consumers with an attractive offer and forming significant interest in purchasing new products in a highly competitive market. After consolidating and forming an economically justified demand for the product, a gradual price increase occurs. It is important to interact with the target audience to form the image of a brand with quality products, since there is a risk of consolidating in the minds of the buyer the idea of cheap products due to low prices at the start of sales.

*Premium pricing*. Brands with luxury goods set a high price to demonstrate prestige. The strategy presented is focused on a target audience with a high-income level and is characterized by a smaller market capacity compared to mass consumer goods. A high price serves as an indicator of the uniqueness of the product and the high social status of its owner. Achieving success in the premium segment involves the use of an effective marketing strategy that allows a company to ensure the elitism of the brand and its products in the long term. Along with the high price of the product, high-quality standards or unique characteristics are also provided, which allows the brand to distance itself from the mass market.

*Competitive pricing*. In conditions of competition for the mass consumer, companies conduct active research into the price offers of other market participants and adjust their prices accordingly. Depending on the company's market position, prices may be set above average with a certain level of deviation, average market values, or lower compared to the main competitors. Given a slight difference in prices between the main competitors, there is a need for a comprehensive impact on the target audience and the formation of a high level of loyalty due to additional characteristics (quality, high level of service, etc.). When implementing the presented strategy, there may be a risk of low profitability if competitors significantly reduce prices and the company needs to introduce similar measures.

*Economy pricing*. The presented strategy is actively used by a large number of companies in Ukraine, since in conditions of war and low purchasing power, users are forced to save and mainly choose low-price offers. Ensuring low prices is achieved at the expense of minimal costs for the production of goods and implementation of related processes. The economy segment is characterized by accessibility for a wide target audience with limited quality characteristics of goods that perform basic consumer functions. The company's focus on economy pricing allows the company to ensure the loyalty of the target audience in limited conditions, since with a greater reduction in competitive prices, users reorient to more loyal price offers. The presented strategy is actively used in supermarkets, which is manifested in the sale of own brands at relatively low prices.

*Cost-plus pricing*. Focusing on all costs and adding a certain level of markup is the basis for implementing this pricing strategy. Due to the correct calculation of the cost of products, it is possible to ensure an economically

justified level of profitability. Due to the simplicity of calculations, the presented pricing strategy has become widespread in various types of economic activity. However, ignoring the complex factors of the competitive environment when using cost-plus pricing reduces the demand for the company's products in conditions of price reduction by other market participants who actively use flexible pricing. Taking into account only costs in certain cases can lead to undervaluation of the product and under-receiving profit due to lower prices than individual groups of consumers are willing to pay. The inability to take into account the value of the product for the target audience due to ignoring current needs is a significant drawback of this pricing method.

*Bundle pricing*. Companies offer customers the chance to purchase several products or services at the same time, which allows customers to save compared to purchasing these products separately. Creating a sense of benefit in the customer due to lower total costs allows the company to increase the average check. The presented pricing strategy also allows companies to optimize inventory in warehouses and promotes the sale of less popular products. Bundle pricing is advisable for products that complement each other in some way and can be positioned on the market as an attractive package offer. Effective implementation of package offers involves a comprehensive market analysis and identification of potential customer needs, since a significant number of modern consumers have a negative attitude towards the imposition of additional products.

*Psychological pricing*. The presented strategy involves setting prices with certain numbers at the end. The number 9 is associated with an offer with a lower price, and the price ending in 0 is perceived by many users as evidence of a more expensive and high-quality product. The formation of an attractive price through psychological influence allows the target audience to achieve a sense of benefit and stimulates impulsive purchases. Manipulations with numbers on price tags prove their effectiveness, especially when placing several products from the same category next to each other, which forces users to subconsciously compare available offers and choose a "more profitable" option. Psychological pricing has a very limited impact on customers from the premium segment and consumers who make informed decisions.

*Dynamic pricing*. The intensive development of e-commerce and the growth in the number of companies that actively use digital marketing tools to interact with the target audience on the Internet contribute to the intensification of the use of dynamic pricing. When implementing dynamic pricing models, an information base is used, which periodically accumulates data that is used to adjust the price of the corresponding products. Depending on the industry and the specifics of the product, prices can change within minutes (ridesharing) to several times a week (hospitality). For mass consumer goods, including food and electronics, the most common practice is to adjust prices once a day, but in this area, thanks to innovations, more flexible approaches are possible. Among the industries that actively use

dynamic pricing, it is advisable to pay attention to e-commerce (Amazon, Media Markt), airlines (Lufthansa Group, Delta Airlines, Ryanair), hospitality (Airbnb, Marriott, Hilton), and ridesharing (Uber, Lyft, Bolt).

The main strategies of dynamic pricing are:

- Demand-based dynamic pricing – price formation based on the ratio between demand and supply for a given product. During a period of significant demand growth, a corresponding increase in the price of a product or service is observed.
- Time-based dynamic pricing – price adjustment based on the seasonality factor, day of the week, or hour of the day. The time factor significantly affects the behavior of a significant number of users and fluctuations in their activity in purchasing goods and services in certain time intervals.
- Competitor-based dynamic pricing – orientation on competitors' pricing systems. In the context of digitalization and comparison by a significant number of users of price offers from different companies, there is a need to monitor the market and form a competitive price in specific conditions.
- Dynamic discounts and flash sales – implementation of an effective marketing strategy, which uses temporary discounts or special offers, involves activating demand for the product for a short time. The presented approach should meet the long-term interests of the company in establishing close and effective communications with the target audience and not satisfy only short-term goals.
- Bundle pricing – the presented strategy involves stimulating demand for several products at the same time, which are offered in one package at a reduced price. Accordingly, the consumer must realize that purchasing the presented products separately will cost more.
- Event-based dynamic pricing strategy – pricing in accordance with certain events (holidays, promotions, thematic events, etc.). According to current events, price offers are provided that encourage the target audience to buy thematic goods and services.
- Personalized dynamic pricing – researching the behavior and preferences of a particular consumer over a certain period and forming individual price offers. Thanks to the use of powerful mathematical algorithms and the accumulation of retrospective information about the client's purchase history, it is possible to offer the optimal price and increase the conversion rate.
- AI-powered dynamic pricing – the presented pricing model is a more advanced pricing approach, as it involves the use of modern and high-performance machine learning algorithms based on big data. Along with the use of heterogeneous information (structured, semi-structured, and unstructured data), it involves constant training of algorithms and optimization of prices in real time (Kondrat, 2024).

Summarizing the main characteristics of dynamic pricing, the following advantages can be distinguished:

- Price Optimization. Price elasticity by the existing demand and supply allows the company to quickly adapt to the needs of users. When reducing requests from the target audience, it is possible to offer significant discounts, and if a significant increase in customer interest is identified, prices can be increased symmetrically.
- Improved Sales Volume. Due to the large number of dynamic pricing strategies for specific conditions, it is possible to choose the optimal approach and stimulate demand for the company's products in the digital environment. Globalization processes contribute to expanding the reach of the target audience and the simultaneous use of several dynamic pricing strategies in different countries or regions.
- Competitive Edge. The introduction of dynamic pricing in Ukraine for many categories of goods is advisable to consider as a competitive advantage, since a significant number of companies use less flexible approaches to pricing. The speed of changing prices under the influence of a complex of factors in the digital environment allows stimulating user interest and contributes to increasing sales.
- Customer Personalization. By segmenting users according to a system of indicators, specific groups are identified for which it is possible to offer special price offers. In the future, thanks to the integration of artificial intelligence into pricing, companies will move to hyper-personalized approaches.

The presented dynamic pricing strategies are selected following the specifics of the company's activities and the data used. The interaction between companies and users in the digital environment allows for the simultaneous use of several dynamic pricing strategies, provided that two or more communication channels are implemented simultaneously.

## 2. Online platforms for consumer electronics in Ukraine

In the 21st century, the growing popularity of the Internet among modern generations has contributed to the active development of e-commerce and the formation of new models of interaction between companies and users. There is a gradual reorientation from offline purchases to ordering individual product categories in the online environment. The consumer electronics market of Ukraine, in accordance with global trends, is characterized by a high level of product sales through web resources. A significant number of representatives of generations Y, Z, and Alpha are actively interested in new products among such categories of gadgets as smartphones, laptops, smart TVs, game consoles, smart watches, etc., viewing relevant thematic content on YouTube, Instagram, and other web resources. *Figure 2* presents the actual and forecast values of the Consumer Electronics Market Size for 2023–2034.

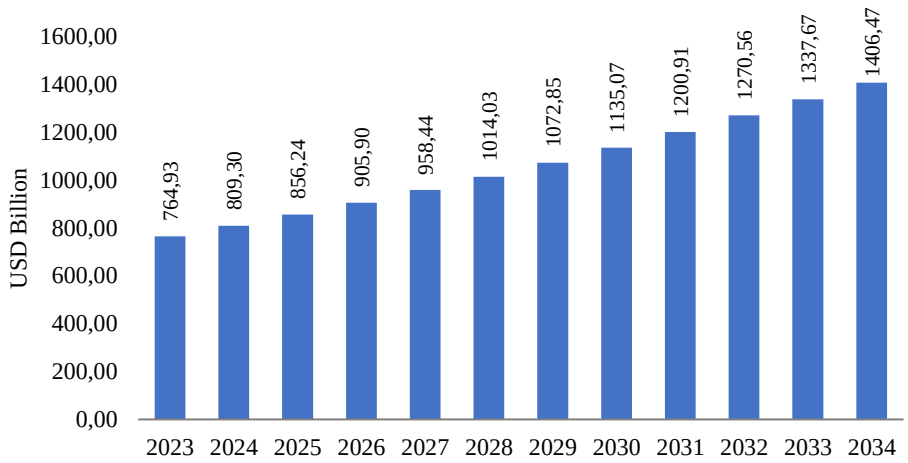


Figure 2. Consumer electronics market scale, 2023–2034

*Source*: (Precedence Research, 2023, October 19).

The gradual growth of the consumer electronics market is inextricably linked to the intensification of competition between companies, primarily on the Internet. Ensuring competitive advantages in the long term involves the implementation of effective marketing strategies through the use of relevant digital tools. The high level of competition on the Internet and the dynamics of the development of functioning markets require companies to respond promptly and make appropriate adjustments to marketing communications with the target audience. The combination of effective digital marketing tools allows achieving optimal results in specific spatial and temporal conditions (Iankovets, 2025).

In the conditions of war in Ukraine, there is a decrease in the standard of living of the population and interest in more attractive price offers. Along with this, representatives of modern generations are forming a demand for electronic gadgets, which are perceived as an important element of everyday life and are used for work, study, leisure, communication, etc. Social and economic instability in Ukraine leads to the consideration of the price factor when choosing goods and services in the offline and online environment. Optimization of digital marketing strategies occurs following comprehensive information, including web analytics data. By analyzing user behavior on an ongoing basis on the company's web resources according to the selected metrics system and studying the peculiarities of market development, it is possible to develop an effective dynamic pricing system that will contribute to the formation of target audience loyalty and stimulate the achievement of an effective conversion level.

The process of finding the best price offers by a significant number of users in Ukraine involves the use of search engines, marketplaces, price aggregators, and offers from various online stores. Marketplaces and price aggregators are popular among retailers as third-party platforms for placing product offers. *Table* presents the differences between the two platforms on the Internet.

*Table*

Differences between marketplaces and price aggregators

| Characteristics | Marketplaces | Price aggregators |
|---|---|---|
| Product presentation | Each seller has the opportunity to create their own online store on the marketplace | Product catalogs by categories, models and other parameters |
| Ordering and purchasing | Users order and complete the purchase process directly on the marketplace | Ordering and purchasing the product is done after clicking on the link to the seller's website |
| Monetization | Companies pay a subscription fee for using the marketplace and a commission for each product sold | The company pays the marketplace a small fee for posting the price list, and also pays for each user's visit to its site |

*Source*: developed and supplemented by the authors from (Zaitseva et al., 2024).

Marketplaces and price aggregators are valuable resources for monitoring prices for competitors' products on the Internet, allowing companies to optimize their pricing strategies and ensure a high level of sales. As part of the fight against dumping, manufacturers and official retailers can also use marketplaces and price aggregator sites to search for unscrupulous partners who unreasonably lower prices for goods and services. Monitoring price offers on the presented resources on the Internet can be carried out in manual or automated modes. Given the significant number of companies that sell products on the consumer electronics market, it is advisable to use specialized tools to accumulate data on prices for the products under study. Parsers are actively used in marketing research, which, by the selected criteria, constantly collect relevant information on the specified web resources. The architecture features of marketplaces and price aggregators make parsers an effective tool for accumulating comprehensive information about posted products daily. The results obtained can be used to conduct a comparative analysis of prices for similar products from different companies, identify seasonality of price offers, and predict the dynamics of cost characteristics of the studied product range. In general, marketplaces are characterized by a wider range of products than price aggregators. Due to the versatility of marketplaces, users have the opportunity to purchase food, FMCG, household appliances, toys, etc. Along with this, a smaller range of products is inherent in a significant number of price aggregators. The large capacity of the consumer electronics market and the intensive growth of demand for innovative products at the global and national levels have led to the emergence of a large number of marketplaces and price aggregators with corresponding product offers. In 2025, among domestic platforms, the leaders in terms of electronics assortment are Rozetka and Prom. Along with this, in the consumer electronics market in Ukraine, the most popular price aggregators are Hotline.ua, Price.ua, E-Katalog (Ek.ua), Magazilla.ua, and Skidka.ua.

## 3. Dynamic Pricing Models to Optimize Marketing Strategies

Representatives of generations Y, Z, and Alpha form the main demand for products in the consumer electronics market in many countries. Among gadgets, the undisputed leader among modern consumers is smartphones, which not only serve to access the Internet and use various applications, but also often act as an element of social status. Particular interest in new smartphone models and their periodic purchase is observed among the younger generations, who consciously or subconsciously compare themselves with their peers in terms of the modernity of gadget functionality. High demand for smartphones, even in the conditions of war in Ukraine, and the presence of a large number of sellers allow using parsing to collect data on the dynamics of prices for the relevant category of goods on the Internet.

A wide range of smartphones in Ukraine in 2025 is presented both on marketplaces and on price aggregators. Having studied the features of the architecture of the presented web resources, it was decided to choose Magazilla.ua to collect information about prices. The presented price aggregator allows you to choose a specific smartphone model according to the selected parameters and receive links to online stores with current prices in the form of a list. Thanks to the use of parsers in the Python programming language, it is possible to automatically collect information about sellers and suggested prices for the corresponding smartphone models daily.

In the process of marketing research of the smartphone market in Ukraine in 2025, data was collected on the dynamics of the most popular model in the premium segment – Apple iPhone 16 Pro Max. The presented smartphone model is characterized by significant popularity among consumers and the presence of a large number of offers from various sellers on the price aggregator website in 2025. Parsing of prices for smartphones was carried out from March 31 to April 27, 2025. *Figure 3* shows the dynamics of the average price of Apple iPhone 16 Pro Max 256GB in the Kyiv region for the studied period. The data obtained indicate certain fluctuations during the week according to the action of certain factors. Based on the data provided, it was decided to implement separate machine learning algorithms to identify trends in price changes for the studied smartphone model to build a dynamic pricing model.

To improve the quality of the machine learning models, according to which the dynamic pricing approach is implemented, the feature engineering process was applied to the collected data (Patel, 2024). After transforming the analysis and the original raw data, it was decided to use the following metrics:

- The actual price of the model from each of the online stores.
- The place of the online store in the national ranking of sites.
- Day of the week (weekday or weekend).
- Lag variable.

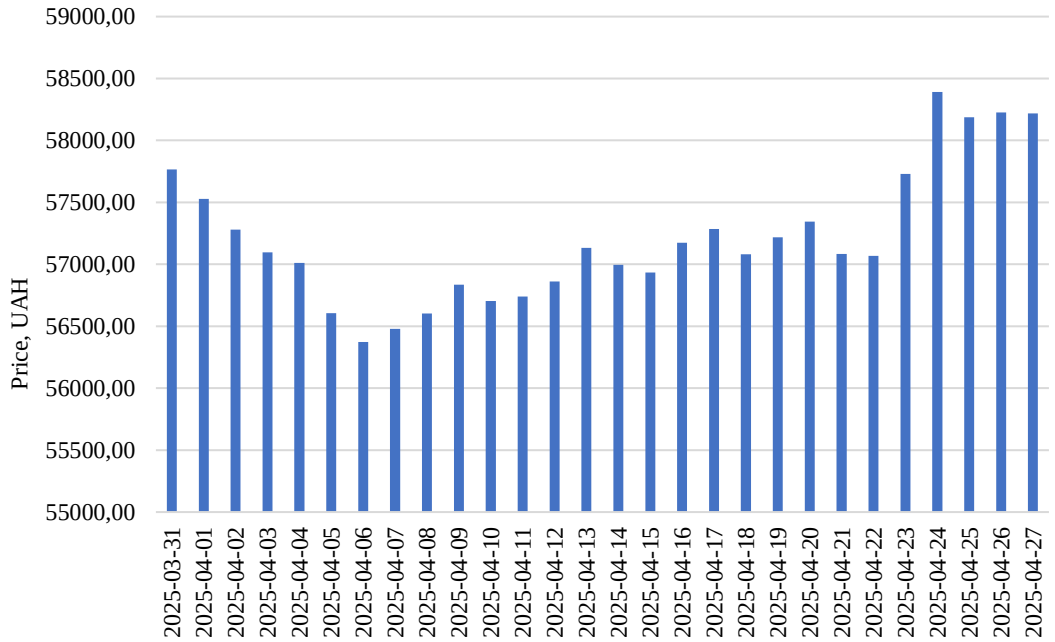


Figure 3. Dynamics of the average price of Apple iPhone 16 Pro Max 256GB in the Kyiv region, from March 31 to April 27, 2025

*Source*: calculated by authors based on (Magazilla, 2025, 27 April).

A comprehensive analysis of the available data and the implementation of various machine learning algorithms have allowed to determine that high results of dynamic pricing are achieved through the use of the CatBoost algorithm (Datacamp, 2024, September 6). The presented algorithm implements gradient boosting based on symmetric decision trees and is characterized by the following advantages:

- has a high level of resistance to overtraining;
- effectively builds models for small and large amounts of data;
- automatically corrects bias in the modeling process.

*Figure 4* shows a comparison of actual and forecasted prices for Apple iPhone 16 Pro Max 256GB during the study period based on CatBoost gradient boosting.

The implementation of the algorithm involved tuning the model hyperparameters using the GridSearchCV method. The following parameter values were identified during the optimization process: depth = 4, iterations = 1000, l2_leaf_reg = 5, learning rate = 0.1. The mean absolute error (MAE) on cross-validation was used to assess quality. Optimization of the CatBoost model based on this criterion involves finding the minimum value for the corresponding time series and the selected tuning parameters. Final training of the model following the best parameters led to the identification of the overtraining effect after 246 iterations, which was taken into account by trimming the model.

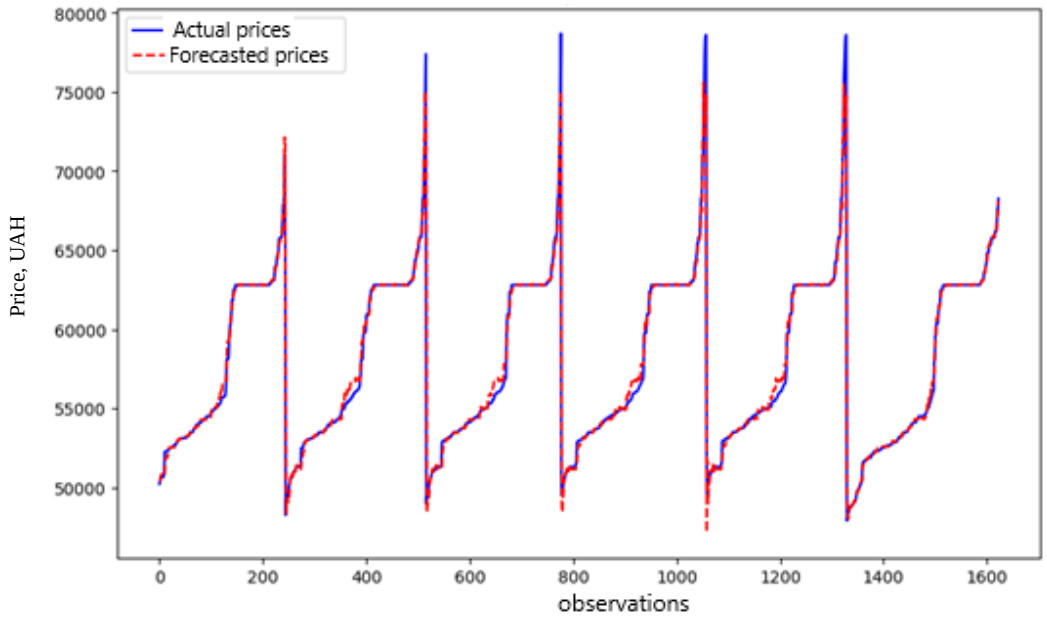


Figure 4. Actual and forecasted prices for Apple iPhone 16 Pro Max 256G in the Kyiv region, from March 31 to April 27, 2025

*Source*: authors' calculations.

Testing the gradient boosting model on an independent sample of Apple iPhone 16 Pro Max 256GB prices from March 31 to April 27, 2027, allowed us to achieve optimal results. For the CatBoost model, the quality indicators were MAE = 250.33, RMSE = 751.53, and the coefficient of determination $R^2$ = 0.98. Therefore, the obtained indicators allow us to conclude that the high quality of the model and its feasibility for predicting new prices for the studied smartphone model.

## Conclusions

Integrating innovations into companies' marketing strategies is an important factor in ensuring competitiveness in the long term. The active introduction of digital technologies is one of the important areas, among which machine learning and artificial intelligence play a key role due to their high productivity and flexibility. In the process of implementing complex mathematical algorithms, companies gain the opportunity to process big data about their processes, as well as apply information about competitors' activities on the Internet.

In the context of intensification of digitalization processes and a significant level of competition, pricing policy must ensure the competitiveness of the company, an economically justified level of product sales, and a positive attitude of customers in the long term. The formation of an effective strategy involves adhering to the following principles: consumer value, competitive environment, product positioning, and pricing strategies. At the current stage of development, 10 main pricing strategies are

distinguished, among which dynamic pricing is one of the most effective due to its adaptability based on big data. Along with this, dynamic pricing is implemented following 8 main strategies that are applied by the used factor systems and allow achieving optimal results. The implementation of effective dynamic pricing models proves its feasibility in the field of e-commerce through the use of automated product sales systems and data based on web analytics services. An approach such as data parsing was used as an effective tool for collecting information. For machine learning, the dynamics of prices for the flagship model of the Apple smartphone were studied.

The results of the research confirm the effectiveness of using machine learning algorithms in studying price dynamics and building specialized models. The use of the gradient boosting model to implement dynamic pricing on the example of the smartphone market in Ukraine has significant prospects, as it allows influencing demand through cost factors. Gradient boosting modeling confirms the hypothesis of the possibility of achieving optimal demand due to the obtained forecast prices for Apple iPhone 16 Pro Max 256GB, which are offered by companies on the Internet on the corresponding days. It is proven that in the conditions of war in Ukraine, the price factor significantly affects the behavior of users, and thanks to the implementation of this machine learning algorithm, the adaptability of prices for the studied model contributes to an increase in the level of loyalty of the target audience to sellers. The presented approaches have not gained significant popularity in Ukraine, but following the experience of advanced countries, they will be gradually introduced by companies. First of all, dynamic pricing based on machine learning algorithms is advisable to implement in e-commerce, since the digital environment allows you to quickly accumulate big data and quickly track changes in the impact of external factors.

Further research will be focused on integrating artificial intelligence into companies' marketing strategies and implementing the principles of hyper-personalization. Thanks to big data and artificial intelligence algorithms, it will be possible to create more productive and flexible dynamic pricing models that will adapt to the characteristics of a specific consumer.

## REFERENCE/СПИСОК ВИКОРИСТАНИХ ДЖЕРЕЛ

Ban, G. Y., & Keskin, N. B. (2021). Personalized dynamic pricing with machine learning: High-dimensional features and heterogeneous elasticity. *Management Science, 67*(9), 5549–5568. https://dx.doi.org/10.2139/ssrn.2972985

Basal, M., Saraç, E., & Özer, K. (2024). Dynamic pricing strategies using artificial intelligence algorithm. *Open Journal of Applied Sciences, 14*(8), 1963–1978. https://doi.org/10.4236/ojapps.2024.148128

Bastani, H., Simchi-Levi, D., & Zhu, R. (2022). Meta dynamic pricing: Transfer learning across experiments. *Management Science, 68*(3), 1865–1881. https://doi.org/10.1287/mnsc.2021.4071

Chenavaz, R. Y., & Dimitrov, S. (2025). Artificial intelligence and dynamic pricing: a systematic literature review. *Journal of Applied Economics, 28*(1), 2466140. https://doi.org/10.1080/15140326.2025.2466140

Datacamp. (2024, September 6). *CatBoost in Machine Learning: A Detailed Guide.* https://www.datacamp.com/tutorial/catboost

| | |
|---|---|
| Iankovets, T. (2025). Digital Marketing and Experience Design, monograph. Kyiv. State University of Trade and Economics. 392. https://doi.org/10.31617/m.knute.2025-51 | Янковець, Т. (2025). Цифровий маркетинг та дизайн вражень, монографія. Київ. Держ. торг.-екон. ун-т. 392 с. https://doi.org/10.31617/m.knute.2025-51 |

Kastius, A., & Schlosser, R. (2022). Dynamic pricing under competition using reinforcement learning. *Journal of Revenue and Pricing Management, 21*(1), 50–63. https://doi.org/10.1057/s41272-021-00285-3

Keenan, M. (2025, March 10). *Top 10 Common Pricing Strategies for Businesses in 2025*. https://www.shopify.com/blog/pricing-strategies

Kondrat, S. (2024, July 9). *What is Dynamic Pricing in Retail & How to Manage it?* https://gepard.io/ecommerce-strategy/what-is-dynamic-pricing-in-retail

| | |
|---|---|
| Magazilla. (2025, April 27). *Mobile phone Apple iPhone 16 Pro Max 256GB*. https://m.ua/ua/desc/apple-iphone-16-pro-max-256gb/ | Magazilla. (2025, 27 квітня). *Мобільний телефон Apple iPhone 16 Pro Max 256GB*. https://m.ua/ua/desc/apple-iphone-16-pro-max-256gb/ |

Nunan, D., & Di Domenico, M. (2022). Value creation in an algorithmic world: Towards an ethics of dynamic pricing. *Journal of Business Research*, (150), 451–460. https://doi.org/10.1016/j.jbusres.2022.06.032

Patel, H. (2024, April 29). *Feature Engineering Explained*. https://builtin.com/articles/feature-engineering#:~:text=Feature%20Engineering%20Definition-,Feature%20engineering%20is%20the%20process%20of%20selecting%2C%20manipulating%20and%20transforming,exploratory%20data%20analysis%20and%20benchmarking.

Precedence Research. (2023, October 19). *Consumer Electronics Market Size, Share, and Trends 2024 to 2034*. https://www.precedenceresearch.com/consumer-electronics-market

Shah, N. H., Rabari, K., & Patel, E. (2021). Dynamic demand and pricing inventory model for non-instantaneous deteriorating items. *International Journal of Mathematical, Engineering and Management Sciences*, *6*(2), 510. https://doi.org/10.33889/IJMEMS.2021.6.2.031

Shin, D., Vaccari, S., & Zeevi, A. (2023). Dynamic pricing with online reviews. *Management Science*, *69*(2), 824–845. https://doi.org/10.1287/mnsc.2022.4387

Suresh, N. V., Selvakumar, A., Sridhar, G., & Jain, V. (2025). Dynamic Pricing Strategies Implementing Machine Learning Algorithms in E-Commerce. *In Building Business Models with Machine Learning*, 129–136. IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-3884-1.ch007

| | |
|---|---|
| Zaitseva, O., Shuklina, V., & Karmazinova, V. (2024). Development of Digital Trading Platforms in the B2C and C2C Market. *Goods and Markets*, *3*(51), 24–39. https://doi.org/10.31617/2.2024(51)02 | Зайцева, О., Шукліна, В., & Кармазінова, В. (2024). Розвиток цифрових торговельних платформ на ринку B2C та C2C. *Товари і ринки*, *3*(51), 24–39. https://doi.org/10.31617/2.2024(51)02 |


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