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Digitalization and Dynamic Pricing as Factors of Increasing the Competitiveness of Trade Enterprises

Abstract. Introduction. The digital transformation of the economy, the rapid development of information technologies, and intensifying competition necessitate the improvement of pricing processes in retail enterprises. Under these conditions, dynamic pricing has become one of the key instruments for enhancing the competitiveness of retail enterprises and strengthening their ability to adapt to changes in the market environment.

Purpose. The purpose of this article is to investigate the theoretical foundations and practical aspects of the digitalisation of pricing processes, substantiate the role of dynamic pricing as a factor enhancing the competitiveness of retail enterprises, systematise contemporary digital technologies for dynamic pricing, and identify their advantages, risks, and practical implementation features in the context of the digital transformation of the economy.

Results. The study reveals the economic essence of dynamic pricing and systematises its main types. Contemporary digital pricing technologies are generalised, including artificial intelligence, machine learning, Big Data, automated price monitoring systems, assortment management systems, and electronic shelf labels. The impact of dynamic pricing on the competitiveness of retail enterprises is substantiated through improved pricing flexibility, personalised pricing offers, inventory optimisation, increased profitability, and enhanced responsiveness to changes in the market environment. The advantages, risks, and specific features of applying artificial intelligence technologies in pricing decision-making are also identified.

Conclusions. The findings demonstrate that the digitalisation of pricing processes and the implementation of dynamic pricing systems constitute one of the key strategic directions for enhancing the competitiveness of retail enterprises. The effectiveness of their application depends on the level of an enterprise's digital maturity, the quality of analytical support, its readiness for organisational transformation, the integration of advanced digital technologies into pricing management, and adherence to the principles of transparency, non-discrimination, and customer orientation in pricing policy.

Keywords: pricing digitalization; dynamic pricing; trade enterprises; competitiveness; artificial intelligence.

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Цифровізація та динамічне ціноутворення як чинники підвищення конкурентоспроможності підприємств торгівлі

Анотація. У статті досліджено теоретичні та практичні аспекти цифровізації процесів ціноутворення та динамічного ціноутворення як ключових чинників підвищення конкурентоспроможності підприємств торгівлі в умовах цифрової трансформації економіки. Розкрито економічну сутність динамічного ціноутворення як адаптивного механізму управління цінами, що базується на аналізі великих даних, алгоритмах машинного навчання та технологіях штучного інтелекту. Систематизовано основні види динамічного ціноутворення та сучасні цифрові технології його реалізації – від базових автоматизованих правил до повністю автономних AI-систем. Обґрунтовано вплив динамічного ціноутворення на підвищення конкурентоспроможності підприємств торгівлі через забезпечення цінової гнучкості, оперативного реагування на зміни ринкової кон'юнктури, персоналізацію цінових пропозицій, оптимізацію управління товарними запасами та зростання прибутковості. Узагальнено переваги, ризики та особливості практичного застосування сучасних цифрових технологій і штучного інтелекту у процесі прийняття цінових рішень. Зроблено висновок, що цифровізація процесів ціноутворення та впровадження систем динамічного ціноутворення є одним із стратегічних напрямів підвищення конкурентоспроможності підприємств торгівлі, а ефективність їх застосування визначається рівнем цифрової зрілості підприємства, якістю аналітичного забезпечення та готовністю до організаційних змін.

Ключові слова: цифровізація ціноутворення; динамічне ціноутворення; підприємства торгівлі; конкурентоспроможність; штучний інтелект.

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Formulation of the problem. The current challenges affecting Ukraine's agricultural sector, including energy dependence, environmental degradation and socio-economic decline in rural areas, require a fundamental shift towards sustainable and resilient energy solutions. As a cornerstone of national food security and a significant contributor to the country's GDP, agriculture is inherently energy-intensive and increasingly vulnerable to external shocks in the energy supply, price volatility in fossil fuel markets and the escalating consequences of climate change.

In this context, the Ukrainian agricultural sector must respond to both immediate operational energy needs and the long-term imperative of aligning with broader global and European environmental strategies. European integration brings with it additional responsibilities and new opportunities. On the one hand, Ukraine must harmonize its environmental and energy legislation with EU directives, including those related to climate neutrality, carbon emission reductions, and the promotion of renewable energy. On the other hand, the EU's Green Deal and Common Agricultural Policy (CAP) provide a framework for financial, technological and institutional support that could accelerate the transition to a more environmentally friendly Ukrainian agriculture.

Despite Ukraine's agricultural sector having natural resources, technical potential and international partnerships, the current state of renewable energy integration remains fragmented and underdeveloped. Key obstacles include a lack of policy coherence, limited access to green financing for farmers, inadequate infrastructure and low awareness of modern energy technologies among rural populations. This situation contrasts sharply with that in EU countries, which have successfully implemented renewable energy systems in rural areas, often transforming farms into energy producers through the use of solar farms, wind turbines, biogas plants and biomass utilisation.

The central research problem is therefore the lack of a coherent, scalable and integrative strategy for embedding renewable energy into Ukraine's agricultural development model. There is an urgent need to examine how various renewable energy technologies can be systematically integrated into agricultural practices to enhance not only energy efficiency and environmental sustainability, but also the economic revitalisation of rural areas. This includes evaluating the institutional mechanisms, policy instruments, and investment models that could facilitate such a transition.

Addressing this issue is critical for achieving multiple national objectives, such as strengthening energy independence, meeting international environmental commitments, modernising agriculture, and ensuring the socio-economic uplift of rural communities. Therefore, developing a strategic approach to managing renewable energy in agriculture should be a priority for national policy and scientific research.

Analysis of recent research and publications. The development of renewable energy in agriculture is a topic that has attracted increasing scholarly attention in Ukraine and around the world, particularly given the urgent need for sustainable rural development and climate adaptation. Recent research highlights the multiple benefits of using renewable energy in agriculture, including environmental protection, increased energy efficiency, economic revitalisation and improved social outcomes for rural communities.

A prominent contribution to this field of study is that of I. Doronina [1], who examines the legal, technological and economic foundations for expanding the use of renewable energy in rural areas. She emphasises the necessity of a robust legal framework to support solar, wind and biomass energy initiatives in Ukraine and proposes specific regulatory tools to facilitate this transition.

H. Hryhoryeva focuses on state support mechanisms for renewable energy in agriculture, emphasising the economic feasibility and environmental benefits of biogas, biomass and solar energy projects. Her research provides valuable insights into how state policies can encourage adoption at farm level.

O. Chumachenko's research [3] focuses on the strategic role of renewable energy in maintaining the energy balance of Ukraine's agro-industrial complex. His research explores solutions for a stable and decentralised energy supply in the event of critical infrastructure damage, emphasising the importance of renewable energy for ensuring energy security.

International case studies have also informed Ukrainian academic discourse. E. Freier, I. Lishchynskiy and M. Lyzun [4] examine Eastern Germany's experience of promoting renewable energy in agriculture. Their findings reveal effective policy instruments, funding mechanisms and institutional practices that could be adapted to the Ukrainian context.

Taking a broader European perspective, I. Gernego and O. Liakhova [5] examine EU initiatives that support renewable energy in rural development. They suggest that integrating Ukraine into EU frameworks could accelerate the adoption of renewable technologies. Similarly, N. Bobrovska, A. Sukhorukova and A. Burkovska [6] examine the influence of European integration on business transformation processes, including those in agriculture and energy.

A. Poltorak, O. Khrystenko, A. Sukhorukova, T. Moroz and O. Sharin [7] introduce an innovative methodological perspective, proposing an integral approach to assessing the impact of innovation and household financial security on sustainable resource use, including energy. Their research highlights the intersection of financial policy, innovation, and sustainability.

A. Burkovska, O. Shebanina, T. Lunkina and others [8, 9] further develop the link between renewable energy and rural sustainability by examining how renewable energy strategies can enhance food security,

environmental health and rural well-being. Their work emphasises the need to integrate technological, environmental, and socio-economic dimensions into national development strategies.

Finally, global studies by scholars such as T. Pimonenko et al. [10] and D. Gielen and K. Hansen [11, 12] provide insights at a macro level into the global energy transition, ethical considerations and the role of agriculture in achieving climate goals. These studies contextualise Ukraine's challenges within broader energy policy and sustainable development trends.

Overall, recent literature provides a strong conceptual and empirical basis for understanding the role of renewable energy in agriculture. However, there is still a need to synthesise these insights into a unified national strategy. The present study aims to address this issue by offering a strategic vision based on comparative analysis, policy alignment and rural development needs.

Formulation of research goals. The purpose of this article is to investigate the theoretical foundations and practical aspects of the digitalisation of pricing processes, substantiate the role of dynamic pricing as a factor enhancing the competitiveness of retail enterprises, systematise contemporary digital technologies for dynamic pricing, and identify their advantages, risks, and practical implementation features in the context of the digital transformation of the economy.

Presentation of the main research material. In the current context of a highly volatile market environment, the digitalisation of business processes, and intensifying competition, retail enterprises are compelled to continuously adapt their pricing strategies to new economic realities. One of the most effective instruments for improving the effectiveness of pricing policy is dynamic pricing, which is becoming increasingly widespread in modern retail practice. Dynamic pricing is a flexible pricing management mechanism that involves the prompt adjustment of prices in response to changes in market conditions, demand, consumer behaviour, competitors' prices, seasonal fluctuations, inventory levels, and other internal and external environmental factors.

Dynamic pricing is a pricing strategy that involves the continuous or regular adjustment of prices for goods or services based on the analysis of current market signals, including demand levels, inventory availability, competitors' prices, time of day, seasonal factors, and customers' demographic and behavioural characteristics.

Unlike traditional static pricing, which is based on the «cost-plus» approach or the establishment of a fixed market price for an extended period, dynamic pricing functions as an adaptive system that continuously updates pricing decisions in accordance with changes in

the enterprise's internal and external environment. From a theoretical perspective, dynamic pricing is grounded in the concepts of price discrimination (first-, second-, and third-degree), revenue management, and auction theory.

At present, pricing theory and practice distinguish three main types of dynamic pricing:

- demand-based pricing – price differentiation based on the level of demand (e.g., higher prices during peak hours);
- competitive-based dynamic pricing – the automatic adjustment of prices in response to changes in competitors' prices (repricing);
- time-based pricing – price adjustments based on time-related factors (e.g., different prices on different days of the week or during different seasons);
- segmented (personalised) pricing – personalised pricing based on the profile of an individual customer.

An important prerequisite for the effective implementation of dynamic pricing at an enterprise is the continuous monitoring of the market environment and the prompt analysis of large volumes of data (Fig. 1). In this context, particular importance is attached to monitoring competitors' prices, analysing demand patterns, identifying consumer trends, and forecasting changes in consumer market behaviour.

Through the use of modern information technologies, enterprises are able to automate the processes of data collection and processing, thereby significantly improving the accuracy and speed of managerial decision-making in the field of pricing.

The effective application of dynamic pricing mechanisms requires a systematic approach to monitoring the competitive environment. Category managers should continuously analyse competitors' assortment policies, monitor changes in their prices, promotional offers, marketing activities, and product availability. Such an approach enables enterprises to identify new market opportunities in a timely manner, assess the level of pricing pressure, and adjust their pricing policy in accordance with current market conditions.

For the practical implementation of dynamic pricing, enterprises are advised to use specialised price monitoring tools, automated assortment management systems, and analytical software solutions. Their adoption reduces the time required for routine analytical tasks, improves forecasting accuracy, and enhances the key performance indicators of enterprise operations. An important element of this process is the regular verification of the reliability of the collected data, including through test purchases or the use of independent price monitoring services.

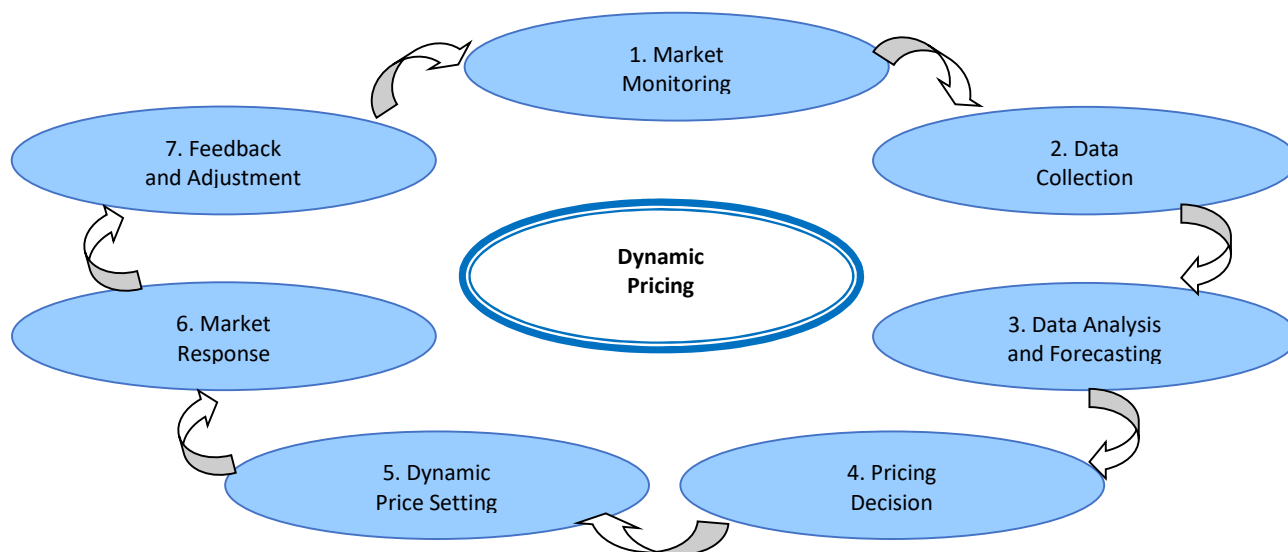


Figure 1 – The Price Formation Mechanism in a Dynamic Pricing System

Source: Developed by the authors.

The key technological foundation of modern dynamic pricing is machine learning (ML) and deep learning methods, which make it possible to process large volumes of heterogeneous data (transaction data, competitors' website data, meteorological data, and social media data). Based on these forecasts, the algorithm autonomously determines price adjustments within the parameters established by management.

The digitalisation of pricing in trade encompasses a wide range of technological tools that can be classified according to their level of complexity and the degree of autonomy in pricing decision-making.

The highest level – AI-driven dynamic pricing – involves the application of machine learning algorithms and big data technologies to enable fully autonomous pricing decisions. Systems such as Revionics (Aptos), Pricemoov, and Omnia Retail simultaneously analyse dozens of parameters, including conversion rates, website visitor behavioural patterns, weather conditions, the outcomes of sporting events, and social media trends, to generate an individual price for each customer or customer segment at a specific point in time.

An important component of the technological infrastructure supporting dynamic pricing in brick-and-mortar retail is the use of Electronic Shelf Labels (ESL). ESL technology, based on Bluetooth or NFC protocols, enables prices to be updated simultaneously in the information system and on store shelves without requiring physical intervention by employees. This eliminates one of the principal operational barriers to implementing dynamic pricing in offline retail, namely the excessive labour required for manual price relabelling.

The competitiveness of a commercial enterprise is determined by its ability to maintain and expand its market share while ensuring an adequate level of profitability. Dynamic pricing influences the competitiveness of enterprises in the retail sector through several interrelated mechanisms.

First, it enhances price flexibility and responsiveness. Enterprises that employ dynamic pricing systems are able to respond to competitors' price changes in real time – within minutes or hours rather than weeks. This fundamentally transforms competitive dynamics, making price a tool of continuous competition rather than a static indicator reviewed only periodically.

Second, it contributes to revenue and profitability maximisation. Dynamic pricing enables enterprises to capture consumer surplus during periods of increased demand while stimulating demand through price reductions during periods of weak market activity.

Third, it facilitates the personalisation of pricing offers. Algorithmic pricing systems enable enterprises to identify customer segments with different levels of price sensitivity and offer differentiated prices, personalised discounts, or individual coupons. Personalised pricing enhances customer loyalty and creates a competitive advantage by better addressing the needs of each customer segment.

Fourth, it improves inventory management. Integrating dynamic pricing systems with inventory management enables enterprises to automatically reduce prices for products with excessive stock levels or approaching expiration dates, thereby minimising losses associated with product write-offs. This is particularly

important in food retailing, where inventory losses may have a substantial impact on overall profitability.

In recent years, the increasing digitalization of retail has shifted the focus of pricing management from purely revenue optimization toward customer-oriented value creation. The widespread use of artificial intelligence, big data, and personalized pricing technologies has enabled retailers to adapt prices to individual customer preferences and real-time market conditions. However, these technological advances have also intensified concerns regarding consumer privacy, transparency, and the ethical use of personal data. As dynamic pricing systems become increasingly dependent on customer information and behavioral analytics, maintaining consumer trust requires retailers to ensure that pricing decisions are transparent, non-discriminatory, and compliant with data protection principles.

In particular, Inman and Nikolova [8], in their study "Shopper-Facing Retail Technology: A Retailer Adoption Decision Framework Incorporating Shopper Attitudes and Privacy Concerns", argue that pricing technologies based on customer data and real-time analytics should be implemented in a transparent and customer-oriented manner, as concerns regarding data privacy and perceptions of unfairness may adversely affect consumer trust and purchase intentions. The authors demonstrate that the successful adoption of digital retail technologies depends not only on their technological capabilities but also on consumers' perceptions of usefulness, convenience, fairness, and data privacy.

Consequently, customer orientation and privacy protection have become essential prerequisites for the successful implementation of AI-driven pricing strategies in modern retail.

Despite its considerable advantages, dynamic pricing is associated with certain risks and limitations. Excessively frequent or unjustified price changes may negatively affect consumer trust and the reputation of an enterprise. The use of aggressive price discrimination strategies is particularly risky when product prices increase substantially during periods of peak demand. Such practices may provoke negative consumer reactions, reduce customer loyalty, and damage a company's reputation.

Garbarino and Maxwell [9] argue that consumers evaluate pricing practices not only according to economic outcomes but also in terms of perceived fairness and adherence to established pricing norms. When pricing behavior violates these norms, consumers are more likely to experience dissatisfaction, lose trust in the seller, and reduce their purchase intentions, even if the offered price is objectively favorable.

Agrawal, A., Gans, J. S., & Goldfarb, A. [1] complement this perspective by emphasizing that the growing adoption of artificial intelligence in pricing decisions should not eliminate the role of human judgment. The authors argue that AI primarily enhances the accuracy of demand forecasting and market

prediction, whereas managerial judgment remains essential for evaluating the fairness, strategic appropriateness, and long-term consequences of pricing decisions. Consequently, the effectiveness of AI-driven dynamic pricing depends not only on the predictive performance of algorithms but also on the ability of managers to balance revenue optimization with customer trust, ethical considerations, and sustainable competitive advantage. This integrated approach highlights the importance of combining algorithmic intelligence with human expertise to ensure that dynamic pricing contributes to both financial performance and long-term customer relationships.

An excessively high frequency of price adjustments or consumers' perceptions of unfair price differentiation may adversely affect customer loyalty, particularly in product categories where consumers expect price stability. Furthermore, in oligopolistic markets, algorithmic pricing may lead either to «price wars» or, conversely, to tacit price coordination among competitors. Such outcomes may have anti-competitive effects and become subject to regulatory scrutiny.

Dixit, Braunsberger, Zinkhan, and Pan [10] investigated the role of information technologies in the development of contemporary pricing strategies and analysed their managerial and regulatory implications. The authors argue that the integration of information technologies into pricing processes enables firms to implement flexible dynamic pricing mechanisms based on real-time market information, customer characteristics, and competitive conditions. At the same time, they emphasise that the growing adoption of digital technologies in pricing requires careful consideration of consumer price perceptions, pricing transparency, and compliance with regulatory requirements in order to prevent unfair pricing practices and maintain consumer trust. The authors conclude that the effectiveness of contemporary digital pricing strategies depends on achieving an appropriate balance between revenue maximisation, consumer acceptance of pricing decisions, and compliance with ethical and regulatory requirements.

At present, both international and Ukrainian retailers are actively implementing dynamic pricing strategies and exploiting the capabilities of digital technologies to achieve sustainable competitive advantages in attracting and retaining customers. The rapid development of artificial intelligence, machine learning, and advanced analytics has significantly expanded firms' ability to adjust prices in real time according to changes in market conditions. Contemporary dynamic pricing systems analyze multiple factors simultaneously, including demand fluctuations, competitors' prices, inventory levels, customer segmentation, seasonal patterns, and historical purchasing behavior, enabling firms to optimize prices while improving revenue performance and market responsiveness [6, 7]. Recent studies further demonstrate that the widespread adoption of

algorithmic pricing enhances pricing efficiency but also raises new challenges related to market competition and price coordination among firms [5].

Consequently, AI-driven pricing has become one of the key components of digital transformation in retail, allowing enterprises to respond rapidly to changing consumer preferences and increasingly volatile market environments.

Conclusions. The digitalisation of pricing is a key strategic direction for enhancing the competitiveness of commercial enterprises in the context of the digital transformation of the economy. Dynamic pricing, based on the algorithmic analysis of big data and the application of artificial intelligence technologies, creates significant opportunities for increasing revenue, optimising inventory management, and personalising pricing offers for consumers. At the same time, its effective implementation requires not only technological investment but also comprehensive organisational

changes, including staff training, the transformation of pricing-related business processes, and the development of a data-driven decision-making culture. In addition, enterprises should take into account social and regulatory considerations by ensuring algorithmic transparency, preventing discriminatory pricing practices, and adapting to legislative changes associated with European integration.

Thus, dynamic pricing is one of the most important instruments of modern retail management. Its application enhances an enterprise's ability to adapt to changes in the market environment, contributes to the optimisation of pricing policy, increases profitability, and strengthens competitive positions in the market. The effectiveness of dynamic pricing largely depends on the level of an enterprise's digitalisation, the quality of its analytical support, and management's ability to respond promptly to changes in the external environment.

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