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RENTAL VALUE DRIVERS IN RETAIL REAL ESTATE DEVELOPMENT

Ongoing transformations in the retail real estate market, structural shifts in consumer behavior, and economic and security challenges necessitate a rethinking of approaches to retail real estate development. In the context of intensifying competition, the digitalization of trade, and constrained investment resources, improving the economic efficiency of development decisions and the decisions of retail market participants has become especially important. The research is based on the hypothesis that there is a statistically significant relationship between rental rates for retail properties and a set of macroeconomic and market factors. The aim of the research is to identify and quantify the impact of key external factors on the formation of rental rates in the retail real estate segment. The methodology includes theoretical generalization, systems analysis, comparison, and abstraction, as well as statistical data-processing methods and economic-mathematical modeling. The empirical basis of the study comprises analytical materials from consulting companies, statistical data, and publicly available market reviews. The article analyzes the current state of Ukraine's retail real estate

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ЦІНОУТВОРЕННЯ У ДЕВЕЛОПМЕНТІ ТОРГОВЕЛЬНОЇ НЕРУХОМОСТІ

Сучасні трансформації ринку торговельної нерухомості, структурні зрушення у споживчій поведінці, економічні та безпекові виклики зумовлюють необхідність переосмислення підходів до девелопменту в ритейлі. В умовах посилення конкуренції, цифровізації торгівлі та обмеженості інвестиційних ресурсів особливої актуальності набуває проблематика підвищення економічної ефективності девелоперських рішень та рішень суб'єктів ринку роздрібної торгівлі. Дослідження ґрунтується на гіпотезі про наявність статистично значущого зв'язку між рівнем орендної плати за об'єкти торговельної нерухомості та певною сукупністю макроекономічних і ринкових чинників. Метою статті є виявлення та кількісна оцінка впливу ключових факторів зовнішнього середовища на формування орендних ставок у сегменті торговельної нерухомості. Використано методи теоретичного узагальнення, системного аналізу, порівняння та абстрагування, а також статистичні методи обробки даних і економіко-математичне моделювання. Інформаційною базою дослідження слугували аналітичні матеріали консалтингових компаній, статистичні дані та відкриті ринкові

market, taking into account regional disparities, the influence of security factors, investment constraints, and the transformation of consumer demand. The research demonstrates that retail real estate development is a system-forming factor in rent formation, as it integrates spatial, investment, and management decisions with market conditions. The modeling was carried out using the Kyiv retail real estate market as a case study, as it is the most information-rich and representative segment of the national market. The regression analysis reveals a significant effect of inflation, unemployment, the NBU policy rate, and retail space vacancy on rental dynamics. The findings may be used by developers, investors, and public authorities to forecast changes in rental values and improve the soundness of decisions in the field of retail real estate development.

Keywords: development, retail real estate, rental value, retail, security risks, econometric modeling.

огляди. Проаналізовано сучасний стан ринку торговельної нерухомості України з урахуванням регіональних диспропорцій, впливу безпекових чинників, інвестиційних обмежень та трансформації споживчого попиту. Визначено, що девелопмент торговельної нерухомості є системоутворюючим чинником формування орендних ставок, оскільки інтегрує просторові, інвестиційні та управлінські рішення з кон'юнктурою ринку. Моделювання виконано на прикладі ринку торговельної нерухомості Києва як найбільш інформаційно забезпеченого та репрезентативного сегмента національного ринку. За результатами регресійного аналізу встановлено значущий вплив інфляції, рівня безробіття, облікової ставки НБУ та вакантності торговельних площ на динаміку орендних ставок. Отримані результати можуть бути використані девелоперами, інвесторами та органами управління для прогнозування змін орендної вартості та підвищення обґрунтованості рішень у сфері розвитку торговельної нерухомості.

Ключові слова: девелопмент, торговельна нерухомість, вартість оренди, ритейл, безпекові ризики, економетричне моделювання.

JEL Classification: R33, C10, L81.

Introduction

The retail sector occupies a prominent place in the structure of Ukraine's national economy, demonstrating the resilience of consumer demand under various exogenous conditions. The material and spatial basis for retail activity is real estate, which enables the functioning of different formats of retail and wholesale trade. Retail real estate reflects the current state of development of the retail sector and actively shapes the conditions for its operation. In particular, the type, location, architectural and planning solutions, and level of infrastructure support of retail properties directly affect consumer behavior, purchasing priorities, visit frequency, and length of stay. The parameters of retail real estate shape retailers' demand for retail space, determine the choice of retail formats, and influence assortment policy and service organization.

The main objective of retail development is to maximize project profitability through rental income and an increase in market value. The economic efficiency of retail market participants depends significantly on the characteristics of commercial real estate, the development of which determines the spatial, functional, and qualitative parameters of retail activity. At the same time, the business performance of retail operators depends on development decisions, the investment attractiveness of properties, and the potential for growth in their market value.

For developers, rental income is the main source of return on investment; therefore, an error in forecasting rent can turn a profitable project into a loss-making one. Accordingly, a comprehensive analysis of the factors affecting commercial real estate rents provides the basis for sound management and investment decisions that contribute to maximizing asset capitalization and ensuring strategic resilience amid macroeconomic fluctuations.

The high level of scholarly interest in commercial real estate development is reflected in a substantial body of fundamental and applied research by both domestic and foreign scholars devoted to market conditions and pricing factors. A review of recent studies shows that existing scientific and analytical work is largely generalized and focused on the real estate market as a whole or on commercial real estate broadly, without differentiation by specific property categories.

A systematic analysis of real estate development strategies, emphasizing the role of comprehensive planning, transport accessibility, and functional diversification in improving project efficiency, was presented by Alwee and Gamal (2024). The authors note that the economic efficiency of development projects is largely determined by the degree of integration of spatial, transport, and functional solutions.

Dobrovolska and Fenenko (2024) examine the real estate market in Ukraine and forecast its development using the Brown-Mayer method with Statgraphics software. In particular, they identify critical external factors influencing changes in demand and real estate prices and note that during the war, there was a reorientation of demand toward the rental of commercial premises, primarily warehouses, due to population migration and business relocation to safer regions of the country.

Valuation expert Simonova (2024, April 26) analyzed the impact of the full-scale invasion of Ukraine by the russian federation and identified its long-term consequences for the economy and the real estate market. The author emphasizes the need to assess losses associated with destroyed and damaged real estate in accordance with the International Valuation Standards and the RICS Valuation – Global Standards (Red Book Global Standards). This area of research is also relevant for development companies that have suffered not only direct material losses but also lost profits and increased financing needs for the restoration of property damaged as a result of armed aggression.

Kobzan and Pomortseva's study (2021) provides a solid basis for understanding the transformation of the Ukrainian real estate market, combining a strong theoretical framework with a practical analysis of market conditions. The authors examine the state of the real estate market before major global and local shocks, including the COVID-19 pandemic and the pre-war period, demonstrating the relationship between the construction industry and the real estate market. They also consider structural problems

that have accumulated in Ukrainian development over the years, as well as the logic of price formation in the primary market. In a later study, Kobzan and Pomortseva (2023) provide a systematic overview of the domestic real estate market as of 2023 and examine the impact of geopolitical factors and the full-scale war on market structure. Special attention is paid to valuation methodology during periods of crisis; price indicators and changes in demand and supply are analyzed, along with the implementation of modern technologies such as GIS and PropTech for market monitoring and analysis, which are critical for industry transparency.

Retail real estate analytics are also provided by market experts. In particular, Neposedov (2024, May 20) notes that the Ukrainian commercial real estate market changed dramatically across all segments in 2019–2021 and has continued to transform during the war. The active development of retail trade in previous years led to market saturation with retail space; therefore, against the backdrop of declining consumer sentiment, attendance became more dispersed, vacancy increased, and rental rates declined. According to the author's analysis, a tenant-driven market for retail real estate has emerged in Ukraine, while operators are slowing expansion, refusing investments, reducing renovation costs, and transferring risks to developers.

International experience in forming developers' competitive advantages through the lens of sustainable development is also reflected in the work of Chinese researchers, who view the real estate sector as a strategic foundation of the national economy of the People's Republic of China and focus on the determinants of the competitiveness of large firms in the industry. Using structural equation modeling (SEM), the authors identify key internal influencing factors and demonstrate that the long-term sustainability and market advantages of modern development companies directly depend on the integration of sustainable development principles into their business models (Li et al., 2021).

A review of the available information base, ranging from academic research to industry analytics produced by leading consulting companies, reveals a high degree of abstraction. This underscores the need to move from general conceptual provisions to specific factor analysis focused on the applied aspects of the issue under study.

The research hypothesis is that, under martial law, the traditional mechanism of commercial real estate rent formation is transformed: the dominant influence of macroeconomic and market factors is supplemented by a critical security-risk factor, which, through migration processes and changes in consumer behavior, differentiates rental rates according to regional location and the extent to which a property's development concept can ensure business continuity.

The aim of the article is to identify and quantify the impact of key environmental factors on the formation of rental rates in the commercial real estate segment.

The study addresses the following tasks: to examine the features of commercial real estate development in Ukraine under martial law; to establish the presence and nature of the relationship between commercial real estate rents and macroeconomic, market, and security factors; and to use the results for forecasting commercial real estate rents and for supporting management and investment decision-making by market participants.

The research methodology is based on theoretical generalization and systems analysis; statistical methods of data collection, processing, and grouping to study trends in the retail real estate market; comparison, analysis, and synthesis to provide a comparative characterization of key indicators of Ukraine's retail real estate market by region; regression analysis to assess the impact of factors on retail real estate rents; and induction, deduction, and interpretation to formulate the study's conclusions.

The empirical basis of the research is the official statistical and macroeconomic data of the State Statistics Service, the National Bank of Ukraine, the Ministry of Finance of Ukraine, as well as analytical reports of the Ukrainian Council of Shopping Centers (UCSC) and consulting companies (Colliers, CBRE, PwC, JLL).

The main body of the article consists of two sections. The first describes the directions of transformation in retail real estate development in Ukraine under martial law and reveals the asymmetry of market development and substantial regional differentiation in its key indicators. The second section examines the influence of macroeconomic factors (inflation, the NBU policy rate, GDP, and unemployment), market factors (vacancy rate), and security risks on the rental value of retail properties.

Confirmation of the hypothesis is important for increasing the efficiency of domestic development, especially during the war period, which requires the creation of objects with high adaptability to offset the negative pressure of macroeconomic and security factors on rent. The results obtained can be used to forecast rental rates for commercial real estate and form management decisions by market participants.

1. The transformation of retail real estate development in Ukraine amid military threats and security risks

The specific features of retail real estate development in Ukraine are primarily associated with security risks. The relative safety of the western and central regions of Ukraine, as well as population growth there due to migration, has increased retailers' interest in regional expansion. Kyiv retains its position as the most stable and liquid market, especially in the premium retail real estate segment, where the vacancy rate is minimal and rental rates are rising.

Before the war, the sector demonstrated steady growth focused on large shopping and entertainment centers in major cities. With the onset of the full-scale invasion by the russian federation, however, demand declined,

and activity shifted toward the safer western regions. Despite the wartime challenges, in 2022, new small-format shopping centers with a total leasable area of 51 thousand m2 were opened in the western part of the country. Rental prices in Ukraine fell by an average of 30–40% in the first months of the war compared with pre-war levels, which was reflected in the retail well-being index (RWBI), an indicator that integrates shopping center footfall, vacancy rates, and rental rates. RWBI declined sharply in February–March 2022 to 16.7, but by September of the same year, it had risen to 28.3 (Interfax-Ukraine, 2022, November 7).

According to analysts at CBRE Ukraine and their representative EXPANDIA (Expandia, 2025, March 31), the total volume of competitive shopping center supply in the capital has remained at approximately 1.59 million m^2 in recent years. In total, nine new shopping centers and one additional phase of a previously built center opened in Ukraine in 2025. The total retail area commissioned in 2025 amounted to 161 thousand m^2. Several small retail facilities that do not qualify as shopping centers under the international classification were also commissioned (UCSC, 2025, December 23; UCSC, 2026).

An analysis of the retail real estate market in Ukraine's capital showed that consumer demand and shopping center attendance were positively affected by macroeconomic changes in 2023, including slowing inflation and growth in real GDP. Demand increased, the growth of the consumer price index slowed by 21.1 percentage points, and RWBI reached 29.5 points. The average market vacancy rate showed a downward trend, reaching 15% (–2 percentage points) in 2023. Rental rates in Kyiv for the best spaces (100–200 m^2) in prime locations reached USD 40–65/m^2 per month, an average increase of 8% since the beginning of the year. Rental rates for other facilities increased by an average of 10% and ranged from USD 15 to USD 33/m^2 per month. Retail property owners began returning to fixed rental rates, while turnover-linked rent became less common (CBRE, 2024b). During 2023, the overall trend of active retail expansion in the western regions of Ukraine, primarily by large chain food retailers, continued. A key reason for the steady recovery in consumer demand was large-scale internal migration.

In 2024, the Ukrainian retail real estate market showed signs of recovery amid increased consumer activity, stronger retailer confidence, and the gradual return of international brands. According to UCSC, RWBI reached 29.8 points (+0.3 percentage points), the highest level since the beginning of the war. The frequency of offline shopping recovered (+8% compared with 2023), supporting retailer demand and encouraging businesses to move away from cautious expansion strategies (Deloitte, 2024, March 13).

In Kyiv, by the end of 2024, rental rates for typical shopping gallery units with an area of 100–200 m^2 in prime facilities ranged from USD 40 to USD 70/m^2 per month (+8% since the beginning of the year), while in other facilities, particularly district-format shopping centers, they ranged from

USD 18 to USD 38/m^2 per month (+15% YTD). Owing to growing interest in prime locations, vacancy in prime shopping centers decreased significantly to 14% (–3 percentage points YTD), while district-format shopping centers maintained a consistently low technical vacancy rate of 2–3%. Occupancy improved across most shopping centers in Kyiv against the backdrop of strengthening market fundamentals. Average vacancy rates declined to 12% YTD because of active demand and the lack of new supply (CBRE, 2025).

Rental rates for retail real estate continued to recover and approach pre-war levels in 2025. In prime retail locations in Kyiv, rates reached USD 40–70/m² per month for typical gallery units with an area of 100–200 m², while in other facilities they ranged from USD 18 to USD 38/m^2 per month. The average rental rate increased to USD 17/m^2, which was 30% higher than in the previous year. Vacancy in shopping centers remained elevated, reaching up to 12.9% in January–June 2025 compared with 13.1% at the end of 2024 (Interfax-Ukraine, 2025, November 4).

Table 1 presents a comparison of key indicators of the commercial real estate market across the regions of Ukraine in 2025. The indicators are presented as ranges and estimates based on analytical market reviews.

Table 1

A Comparative analysis of key indicators
of Ukraine's retail real estate market by regions in 2025

Indicator	Ukraine (national level)	Kyiv city	Western regions	Eastern regions
Vacancy rate, %	12–13 (district shopping centers – 6–6.5)	10.5–12 (premium shopping centers – 2–3)	Low with a tendency to decrease	High due to security risks
Rent rate, USD/m² per month	22–24 (areas 50–200 m²)	40–70 (premium), 18–40 (other formats)	15–22 (high street retail), up to 60 (central locations)	3–6
Change in average rental rates, % compared to 2024	10–18	20–30	8–12; in retail hubs up to 25	–15 … –35
New supply of retail space, m²	161 000	11 500	Over 50,000 (partially introduced, partially postponed)	Minimal
Footage, people / 1000 m² GLA	380–400	On average national level	High, especially in regional centers	Reduced

Source: compiled by the authors based on (CBRE, 2024a CBRE, 2024b CBRE, 2025; Colliers, 2025; Nastych, 2025, August 14; PwC & Urban Land Institute, 2025; UCSC, 2025, December 23; UCSC, 2026).

It is projected that the intensification of competition and the moderate pace of post-war recovery in consumer demand will lead to deep differentiation between innovative retail real estate assets and outdated formats. This trend will heighten the need for strategic reconceptualization of existing shopping centers, while retail businesses will be forced to focus on developing comprehensive omnichannel models of consumer interaction (Trubei et al., 2023; JLL, 2025).

Thus, the Ukrainian retail real estate market is characterized by significant regional differentiation driven by a combination of economic and security factors. At the national level, a relatively stable, though elevated, vacancy rate is observed alongside a moderate increase in rental rates. Kyiv retains its status as a key center of retail development, with minimal vacancy in prime properties and the highest rental rates. The western regions remain drivers of regional development due to migration processes, the concentration of business activity, and growing consumer demand. Low rates and high vacancy in the eastern regions constrain development activity and create pent-up demand. These trends point to the asymmetric development of Ukraine's retail real estate market and to the growing role of development and location factors in shaping the economic efficiency of retail market participants.

Conducting a quantitative assessment of the impact of macroeconomic and market parameters on the cost of rent allows us to specify the identified trends and determine the extent of the influence of key environmental factors on the economic results of the operation of retail facilities.

2. Assessment of the impact of key factors on the rental value of retail properties

2.1. Regression analysis of the impact of the policy rate and retail vacancy on rental rates

Analyzing the factors that affect rent is fundamental to retail development. In this area, a forecasting error of 10–15% in the rental rate can turn a profitable project into a loss-making one already at the design stage. In addition, development determines the conceptual content of retail facilities, including the balance between anchor and small tenants, as well as the presence of entertainment, service, and public functions, all of which create a synergistic effect and increase footfall. These factors contribute to tenants' turnover growth, enabling developers and property owners to set higher rental rates or apply combined rental models, in particular, a fixed rate plus a percentage of turnover.

Macroeconomic factors such as inflation, the policy rate, GDP, and unemployment, as well as vacancy rates and security risks, to a certain extent, determine both tenants' (retailers') financial capacity and landlords' strategies. To build the economic-mathematical model, a time series of indicators was constructed based on officially published data: inflation and unemployment rates (State Statistics Service of Ukraine, n. d.), the policy rate and currency indicators (National Bank of Ukraine, n. d.), and gross domestic product indicators (Ministry of Finance of Ukraine, n. d.).

It is advisable to model the influence of factors on rental rates using the Kyiv retail real estate market as an example because of both informational and structural limitations at the national level. The analysis of data on

premium retail properties in the capital's shopping centers is supported by the completeness, transparency, regularity, and analytical coverage of consulting company reports.

In addition, under martial law, regional retail real estate markets in Ukraine are developing extremely unevenly under the influence of security risks, migration processes, and significant differences in business activity. This complicates the formation of a representative national sample and may lead to statistical distortions in the modeling results. By contrast, Kyiv, as the country's largest consumer and business center, concentrates a substantial share of high-quality retail real estate, demonstrates the relative stability of market processes, and at the same time reflects the influence of key factors, which makes it a representative case for studying the mechanisms of rental-rate formation.

At the first stage of modeling, a multivariate logarithmic regression model was used in which the dependent variable, the logarithm of the rent level for retail real estate, and the independent variables, the NBU policy rate and the vacancy rate of retail space, were expressed in natural logarithms. This specification makes it possible to interpret the estimated parameters as elasticity coefficients reflecting the percentage change in rent in response to a percentage change in the relevant factors.

Model parameters were estimated using the Python programming language and specialized libraries for economic and mathematical modeling. In particular, the NumPy library was used for mathematical operations and logarithmic transformations of variables, Pandas for structuring and preprocessing empirical data, and Statsmodels for estimating the parameters of the regression model using the least-squares method.

A 14-year dataset covering the period from 2012 to 2025 was used for modeling, with statistics collected at six-month intervals. During the search for statistically significant relationships, an initial dataset of 14 observations, with one observation per year, was used. However, this limited number of observations did not allow statistically significant results to be obtained. Therefore, the dataset was expanded to 28 observations. As a result, a logarithmic regression model of the following form was obtained:

$$ln(rent) = 2.7409 - 0.3730 \cdot ln(nbur) - 0.2886 \cdot ln(vacancy)\,, \qquad (1)$$

where: *rent* – retail property rental rate per 1 sq. m, USD;
nbur – NBU discount rate, %;
vacancy – retail vacancy rate, %.

The exponential form of the economic-mathematical model is as follows:

$$rent = e^{2.7409} \cdot nbur^{-0.3730} \cdot vacancy^{-0.2886}\,. \qquad (2)$$

In logarithmic form, the coefficients for the independent variables reflect the elasticity of rents with respect to the relevant factors.

In exponential form, the model demonstrates the multiplicative nature of the influence of macroeconomic and market factors, where the discount rate and the vacancy rate of rental space have a restraining effect on the level of rents.

Negative values of the coefficients show that both an increase in the discount rate and an increase in the vacancy rate of rental space in Kyiv have a downward effect on rental rates.

The coefficient of determination, $R^2 = 0.567$, indicates that 56.7% of the variation in the logarithm of rents is explained by variation in the policy rate and the vacancy rate of retail space in Kyiv. The model coefficients and their significance are presented in *Table 2.*

Table 2

Coefficients of the logarithmic model and their significance

Variable	Coefficient	*P-value*	Interpretation
NBU discount rate, ln(nbur)	−0.3730	0.002	A 1% increase in the NBU refinancing rate reduces rent by approximately 0.37%
Vacancy rate of retail real estate in Kyiv, ln(vacancy)	−0.2886	0.011	A 1% increase in the vacancy level reduces rent by approximately 0.29%

Source: calculated by the authors based on the obtained model.

The statistical significance of the estimated coefficients for the variables nbur and vacancy is confirmed by comparing their p-values with the generally accepted significance level of 0.05. For the variable nbur, the p-value is 0.002, and for vacancy, it is 0.011, which is less than the critical value of 0.05. This allows us to confirm the influence of the selected factors on the level of rent within the sample.

The obtained coefficients of the model have an elastic interpretation. In particular, an increase in the discount rate by 1% leads to an average decrease in rent by approximately 0.37%, which reflects the sensitivity of the retail real estate market to changes in monetary policy and the cost of financial resources. At the same time, an increase in the vacancy rate of rental space by 1% leads to a decrease in rent by approximately 0.29%, which indicates the influence of market conditions and an imbalance between demand and supply. A comparative analysis of the coefficient values shows that the macroeconomic factor – the discount rate – has a greater impact on the formation of rental rates than the vacancy factor.

The modeling results indicate a statistically significant and economically justified negative impact of the NBU refinancing rate and the vacancy rate in shopping centers in Kyiv on rent costs. Higher levels of monetary tightening and an increase in the volume of vacant retail space are putting pressure on rental rates, with the impact of macroeconomic factors being greater than the impact of market conditions.

2.2. Modeling the dependence of rent on macroeconomic indicators of inflation and unemployment

At the second stage of modeling, a multivariate logarithmic regression model was applied in which the dependent variable is the logarithm of the rent level for commercial real estate, while some independent variables, in particular the inflation rate and the unemployment rate, are expressed in natural logarithms. This specification makes it possible to interpret the estimated coefficients as elasticities reflecting the percentage change in rent in response to percentage changes in macroeconomic factors. Logarithmic transformation also helps stabilize variance and provides a better approximation of nonlinear economic relationships. Model parameters were estimated using the Python programming language and specialized libraries for econometric analysis. A 14-year dataset covering the period from 2012 to 2025 was used, with statistics collected at six-month intervals, yielding a total of 28 observations. As a result of the calculations, a logarithmic regression model of the following form was obtained:

$$ln(rent) = 5.4402 - 2.1770 \cdot ln(inflation) + 0.4206 \cdot ln(unemp), \qquad (3)$$

where: *rent* – Rent for retail real estate per 1 sq. m., USD;
inflation – Inflation rate in the Ukrainian economy, %;
unemp – Unemployment rate, %.

The exponential form of the economic-mathematical model is as follows:

$$rent = e^{5.4402} \cdot inflation^{-2.1770} \cdot unemp^{0.4206}. \qquad (4)$$

In logarithmic form, the coefficients of the independent variables reflect the elasticity of rents with respect to the relevant factors. In exponential form, the model reflects the multiplicative impact of macroeconomic factors, where inflation and unemployment affect the level of rents differently.

The coefficient of determination $R^2 = 0.409$ indicates that approximately 40.9% of the variation in the logarithm of rents is explained by the variation in the level of inflation and unemployment.

The statistical significance of the model as a whole is confirmed by the value of the F-statistic (8.639) and the corresponding p-value of 0.00141, which is significantly less than the significance level of 0.05. This allows us to confirm the joint impact of the independent variables on rents and to conclude that the model is adequate for analyzing macroeconomic factors of rental rates. The model coefficients and their significance are shown in *Table 3*.

Table 3

Coefficients of the logarithmic model and their significance

Variable	Coefficient	*P-value*	Interpretation
Inflation rate, ln(inflation)	− 2.1770	0.009	A 1% increase in inflation reduces rents by an average of 2.18%
Unemployment rate, ln(unemp)	0.4206	0.002	A 1% increase in unemployment increases rents by an average of 0.42%

Source: calculated by the authors based on the model obtained.

The statistical significance of the estimated coefficients for the variables inflation and unemp is confirmed by comparing their p-values with the generally accepted significance level of 0.05. For inflation, the p-value is 0.009, and for unemp, it is 0.002, both of which are below the critical value of 0.05. This allows us to reject the null hypothesis that the selected factors do not affect rent and to conclude that they have a statistically significant effect within the sample.

The modeling results indicate a statistically significant impact of macroeconomic factors on rental rates. Inflation has a negative effect on rents, which is associated with a decline in tenants' real purchasing power and increased economic uncertainty. It should be noted that under martial law, the relationship between inflation and rent becomes distorted, and rental rates may decline even in periods of high inflation because of falling effective demand. This makes it advisable to assess the impact of the war factor separately.

The positive relationship between the unemployment rate and rental rates in Kyiv during 2012–2025 reflects the specific structural resilience of the capital's market. In the pre-war period, this relationship can be explained by the rapid growth of the city's service economy, where short-term fluctuations in unemployment did not restrain investment demand. During the war period (2022–2025), this effect intensified because of the concentration of solvent demand and relocated capital in Kyiv. The capital remained a priority market for retailers, which made it possible to maintain rental costs at a higher level than in other regions.

2.3. Econometric modeling of the impact of macroeconomic dynamics and security risks on rent

The third model is a semi-logarithmic regression model in which the dependent variable, the logarithm of the rent level, is modeled as a function of the logarithm of GDP and a binary variable reflecting the presence of martial law. This specification allows the coefficient on GDP to be interpreted as an elasticity and the coefficient on the martial-law variable as a percentage structural shift in the level of rent.

For modeling, a 14-year dataset covering the period from 2012 to 2025 was used, with statistics collected at six-month intervals, yielding a total of 28 observations. As a result of the calculations, a logarithmic regression model of the following form was obtained:

$$ln(rent) = 2.0159 + 0.5472 \cdot ln(gdp) - 0.5838 \cdot warcond, \quad (5)$$

where: *rent* – retail real estate rental rate per 1 sq. m., USD;
gdp – Ukraine's gross domestic product, million USD;
warcond – Presence of martial law, binary variable, 0 or 1.

The exponential form of the economic-mathematical model is as follows:

$$rent = e^{2.0159} \cdot gdp^{0.5472} \cdot e^{-0.58380 \cdot warcond.} \quad (6)$$

The coefficient on the logarithm of GDP has an elasticity interpretation: a 1% increase in GDP is associated with an approximately 0.55% increase in rent, all else being equal. The variable warcond captures a discrete effect: under martial law, rent decreases on average by 44.2% ($e^{-0.5838} - 1$), indicating a substantial negative structural impact of the war on the commercial real estate rental market.

The coefficient of determination $R^2 = 0.523$ indicates that about 52.3% of the variation in the logarithm of rent is explained by changes in GDP and the impact of war conditions. The statistical significance of the model as a whole is confirmed by the value of the F-statistic (13.73) and the corresponding p-value of $9.48 \cdot 10^{-5}$, which is significantly less than the significance level of 0.05. This allows us to confirm the joint influence of the independent variables on the logarithm of rent and indicates the adequacy of the model specification.

The statistical significance of the estimated coefficients for GDP and warcond is confirmed by comparing their p-values with the generally accepted significance level of 0.05. For GDP, the p-value is 0.004, and for warcond, it is 0.001, both below the critical value of 0.05. This allows us to reject the null hypothesis that the relevant factors do not affect rent and to conclude that their effects are statistically significant within the sample.

The positive coefficient on GDP indicates that economic growth is accompanied by higher rental rates, reflecting the beneficial effect of macroeconomic expansion on the rental market. At the same time, the negative coefficient on warcond indicates that martial law exerts a significant downward effect on rents, creating a negative structural effect on market functioning.

The constructed regression model confirms the hypothesis that the commercial real estate market depends significantly on both the general economic environment and the security situation. The commercial real estate rental market responds moderately to changes in GDP, while the statistically

significant negative coefficient on warcond demonstrates the severe impact of the war, which caused structural changes in rent formation.

Conclusions

The research results confirm the hypothesis concerning the impact of military risks on rent, the formation mechanism of which has shifted from a purely economic model to a security-oriented one. The security factor has become critical because of changes in consumer demand, business relocation, and population migration. Under such conditions, properties with an adaptive development concept gain a competitive advantage and higher value because they help ensure business resilience to external threats.

Commercial real estate development is a fundamental pricing mechanism that synthesizes investment strategies, architectural and spatial parameters, and management models with the current balance of supply and demand. Commercial development determines the vector of rental-rate formation, acting as the point at which investment decisions, the physical characteristics of a property, and management methods converge within the market environment. Research into the factors influencing rent, therefore, provides the foundation for commercial development, as the accuracy of rent forecasting directly determines project profitability at the design stage.

The results of the economic-mathematical modeling make it possible to formulate conclusions regarding the factors influencing the commercial real estate market. The macroeconomic environment was found to have a stronger effect on rental-rate dynamics than market conditions. Inflation emerged as the most significant negative factor: a 1% increase in the consumer price index leads to a 2.18% decrease in rent because of declining purchasing power. The market also demonstrates an inverse relationship between rent, the NBU policy rate, and the vacancy rate. In particular, a 1% increase in the policy rate and a 1% increase in the share of vacant space lead to decreases in rent of 0.37% and 0.29%, respectively. A moderate positive elasticity of rental rates with respect to GDP was also identified: 1% economic growth generates a 0.55% increase in rates. A specific feature of the Kyiv market is the atypical positive relationship between the unemployment rate and rent. This can be explained by the capital's role as a key hub for capital flows and demand concentration, which modifies traditional crisis patterns. The introduction of martial law caused fundamental structural transformations that significantly changed the parameters governing the functioning of commercial real estate in Kyiv.

Research into the factors that determine rent formation is fundamental to retail development, as it helps minimize investment risks and ensure project profitability through quantitative forecasting of the market's response to macroeconomic fluctuations and security challenges. For retailers, the study provides a basis for optimizing operating costs and benefiting from the synergies of well-designed development even under unstable macro-economic conditions. Promising directions for further research include scaling the econometric analysis to the regional markets of Ukraine as

security disparities diminish, as well as conducting a more detailed study of the influence of the conceptual synergy of retail facilities on the sustainability of rental income in the post-war period.

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