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ASSESSING THE IMPACT OF ECONOMIC VARIABLES ON ROMANIA'S REAL ESTATE MARKET EVOLUTION: RISK, UNCERTAINTY, AND INVESTMENT DYNAMICS

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Abstract. This study examines Romania's real estate market (2003–2023), analyzing economic variables' impact on housing demand and investment trends through PLS-SEM and regression analysis. It addresses housing affordability challenges, particularly for younger generations, highlighting rising prices, increasing costs, and limited mortgage access as key barriers to homeownership. Furthermore, it explores the socio-economic implications of affordability issues, emphasizing their links to inequality and financial vulnerability.

This study examines the shift from consumption to investment in the market, emphasizing the rising demand for real estate. It explores the impact of the sharing economy, particularly short-term rental platforms like Airbnb, on housing prices and affordability. Analyzing economic variables within a supply-demand framework, it distinguishes between new and existing housing stock while incorporating a LCC perspective. The research identifies high-growth market segments, providing insights for policy formulation and investment optimization. It contributes to the debate on government interventions in housing, evaluating whether support should target supply or demand for affordability. Using an ECM, the study examines investment impacts, particularly capital gain speculations, on housing demand, assessing interest rate fluctuations and mortgage dynamics. By integrating historical and current housing prices, it improves market analysis and forecasting, clarifying economic variables' influence on investment behaviour and stability.

Keywords: real estate market, economic variable impact, housing demand analysis, Error Correction Model (ECM) analysis, PLS-SEM.

JEL Classification: E20, E30, M30, R20, R31.

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1. Introduction

The real estate market in Romania has witnessed significant historical events and radical transformations, from the nationalization of properties during the communist era to the restitution of properties in the postcommunist period. It has evolved and adapted to socio-economic changes, including integration into the European Union, the 2008 economic crisis, and current challenges such as rising prices, inflation, the conflict in Ukraine, and the real estate impasse. These factors negatively impact the purchasing power of the population, as well as investment and development opportunities.

Positive economic development and socioeconomic progress have a beneficial impact on the business sector and the population's standard of living. The specialized literature emphasizes the significance of macroeconomic variables, including money supply, national income, exchange rates, gross domestic product, labor force participation, and general price levels, influencing the overall trend of the economy. Furthermore, the interrelationships among price, rent, profitability, and macroeconomics are crucial factors for generating income and have been extensively studied within the commercial, office, and retail real estate sectors.

Housing affordability remains a pressing issue, particularly for younger generations, who face significant challenges in entering the housing market (Hromada, 2024). Limited access to mortgage financing, combined with rising prices and economic instability, has led to growing inequalities in homeownership (Venhoda, 2022). Studies suggest that younger age groups encounter the greatest difficulty in purchasing homes, often relying on parental financial support or opting for long-term rentals. These trends align with global patterns, where affordability constraints are exacerbated by stagnant wage growth and increased living costs (Łuczak & Kalinowski, 2022).

The real estate market exhibits distinct characteristics unique to each economy that can highlight specific savings rates, economic growth, and traditional attitudes toward real estate (C. F. Chen et al., 2021). These characteristics include factors such as the absence of investment channels, transparency, household registration systems, a specific urban policy, financial dysfunctions (Borgersen, 2022). In addition, the rise of the sharing economy, particularly short-term rental platforms like Airbnb, has significantly influenced housing prices, creating affordability challenges in urban centers (Čermáková et al., 2023). Cities worldwide have introduced regulatory measures to mitigate the negative impact of short-term rentals on housing availability for residents. Cumulatively, these features can generate a particular economic behavior manifested in the real estate market. Additionally, indicators such as population income, living standards, and civilization levels also reveal the success or failure of government interventions in implementing macroeconomic policies across different markets in the economy (Gutium, 2019) and their development. Furthermore, culture and derived institutions impact household wealth, consumption, property rights, and ownership in general. Cultural factors also influence the role that children play in determining household consumption and wealth accumulation, including the acquisition of real estate (Hardin et al., 2023).

Income, gross domestic product, inflation rates, and exchange rates have both short-term and long-term effects on housing prices. In contrast, interest rates, diaspora remittances, construction production, and the urban population do not have significant effects on housing prices (Okuta, 2022) in either the short or long term.

From a supply-demand perspective, housing markets function through a combination of new and existing housing stock, with cost structures varying between the two. Life Cycle Cost Analysis (LCCA) is essential for assessing long-term affordability, particularly in the case of historic buildings and new construction projects (Hromada et al., 2021; Pojar et al., 2022). Homebuyers and investors must consider not only initial purchase prices but also maintenance and renovation costs over time.

Savings or investments? Savings and investments are the two essential ingredients in the capital formation of any country, with various options available at both the individual and

macroeconomic levels (Badge, 2021). In particular, the discretionary incomes of Romanians influence investment objectives. Individuals with lower incomes are more inclined to invest in purchasing a home or other goods, while those with higher incomes seek to invest in financial instruments based on accessibility, risk, return, and liquidity. The decision to purchase a home is not arbitrary; households form expectations over time, establishing a dynamic correlation between actual acquisitions and the financial portfolios of the population. However, the decision to buy a home is also influenced by macroeconomics trends that impact households differently (Lyng & Zhou, 2023), such as wage income dynamics, inflation, and exchange rate fluctuations.

Factors affecting portfolio choices are variables representing various aspects of the demographic, socioeconomic, and residential characteristics of households. Household incomes, education levels, occupation, place of residence, and household size prove to be significant variables in explaining the variation in household savings behavior and portfolio choices (Nalin, 2013). Policy considerations must account for whether government support should target supply-side measures, such as housing development incentives, or demand-side interventions, such as subsidies for first-time buyers (Borgersen, 2022). The potential for social housing policies to inadvertently increase market prices and exclude middle-income groups should also be evaluated. The characteristics of current savings depend on the evolution of economic growth. In this regard, economic dynamics and inflationary pressure have eroded the purchasing power of the population, diminishing its capacity to save, as reflected in the evolution of GDP per capita (Danila, 2011). The percentage of monthly income saved is relatively low, highlighting a certain consumption and savings behavior. Given rising affordability concerns, Romanian households increasingly view real estate as a hedge against inflation, prioritizing property investments over alternative financial assets. The significance of this article is explained by the desire to invest in real estate to preserve and increase savings in the face of the economic consequences of the COVID-19 pandemic (Abisheva & Sultankhanova, 2022), inflation, and the decline in real incomes. Thus, real estate investments are the simplest and most easily understood means of preserving and growing the capital of ordinary households.

Households in Romania exhibit a low savings rate compared to a proclivity for consumption. In an environment of limited savings, any increase in active income, income derived primarily from wage earnings, is perceived by the population as permanent. This increase is reflected solely in the growth of consumption expenditures, not in the augmentation of savings or amounts that can be invested over the medium and long term. Global pandemics, like other crises, impact the financial decision-making process. For many individuals, a crisis represents a loss of confidence in the economy, fear of job loss and, by analogy, the subjects assume a deterioration of their own economic situation. Regarding income shocks, consumers manifest three types of financial behavior (Botlíková et al., 2021): realizing consumption, generating debts, or generating savings.

On the other hand, lending conditions, inflation, rising construction costs, and conflict in Ukraine significantly influenced the evolution of the real estate market in direct relation to the financial-banking sector. The increase in interest rates on housing loans has led to the tightening of lending conditions, restricting the population's access to such loans. This has

implicitly altered consumer behavior toward the financial market. Consequently, we observe that consumers who are more cautious about their financial resources in major real estate acquisitions are less willing to succumb to pressure from personal budgets and personal indebtedness. Numerous systemic risks exist in the real estate sector (Lin, 2021), as each regional market is affected by common macroeconomics factors, such as interest rates.

Credit has contributed to economic growth but has also fueled inflation. Measures adopted by the banking system to temper lending have implicitly led to the moderation of the real estate sector's evolution. Thus, the first sectors affected by a decrease in the volume of credit will be real estate and consumption, essentially the main drivers of economic growth. In the past 20 years, the Romanian economy has witnessed an upward dynamic in credit granted to the population, with real estate loans holding a significant share. This trend was influenced by economic growth, positive labor market trends, rising wage incomes, and government support for the population in acquiring homes through various programs. Real estate loans have generally followed the market course, with constant demand irrespective of price movements. Real estate loans have existed and will continue to exist regardless of the values of the IRCC or ROBOR, which are natural indicators reflecting the evolution of the financial market at a given moment.

Exchange rates, real estate market performance, and other specific indicators of the industrial sector are determining factors for prices, rents, and interest rates. Thus, the price-to-rent ratio has frequently been used by real estate practitioners, traders, and policymakers to evaluate a property (Borgersen, 2022). Additionally, the evaluation of a property takes into account other attributes (Lo et al., 2022) important to the population, such as age and structural design, proximity to the labor market, accessibility or distance, the existence of infrastructure, economic centers, and industrial clusters.

Rising inflation has influenced the prices of construction materials, as reflected in the dynamics of the real estate market. In addition to the psychological impact, the war in Ukraine has also affected transaction dynamics in this market, considering China's proximity to this conflict zone. Furthermore, there has been a significant increase in demand for rental housing. The growth in demand, conditioned by developers' capability to adapt to consumer needs, along with the increase in property prices and rents, has allowed for increased transactions. Real estate investments represent one of the safest placements of people's savings. Under these conditions, clients are interested in investing in properties that generate high returns.

The rise in inflation and low interest rates encouraged people to protect their savings by purchasing property, leading to a divergence in prices during the pandemic. The pandemic context notably altered saving-oriented behavior, explaining the increased demand for property acquisition. Romanians prefer to invest in the real estate market based on important factors for the security of their investments (Gnat, 2022).

Thus, the crisis brought about by the COVID-19 pandemic has reshaped the real estate sector, compelling it to adapt to increasing demand driven by the population's desire for comfort and optimized living and working spaces. This shift has redirected buyers' interests toward land, houses, or residential properties, leading to significant price changes. The pandemic has triggered the largest national and global surge in housing prices in the last two decades, fueled by low interest rates, accumulated savings, and the growing need for more space.

Despite its slower pace compared to its pre-pandemic evolution, the real estate market in Romania still holds growth prospects. This is attributed to developers shifting their focus toward large commercial projects and the revitalization of the residential, industrial, and office segments. The decline in inflation and the support of wage growth could contribute to an increased desire among the population to spend or invest in real estate, reflected in a greater number of transactions in the real estate market this year. Overcrowding in major cities and increased accessibility to the residential market are expected to support long-term demand growth. On the other hand, the relaxation of monetary and fiscal policies, coupled with the increase in the population's wages, will maintain a high interest in acquiring real estate, as evidenced by the dynamics of credit for this purpose. High interest rates and currency depreciation negatively impact and will continue to affect the population's loans, increasing the risk of nonrepayment of contracted loans and decreasing the capacity to pay for accumulated debts in the banking system.

In the current economic system, which focuses on the financial banking market, numerous risks may create barriers for the population to obtain loans for real estate acquisition. First, certain dysfunctions at the macroeconomic level across all markets in the economy and the existence of an uncertain legislative framework in the banking sector have direct implications for the population's solvency and the financial-banking sector. Second, the possibility of rising financing costs due to increasing interest rates and currency depreciation reduces the population's ability to pay, with visible effects in the banking sector. Additionally, factors limiting both access to credit for the population and the dynamics of the economic system as a whole, such as fiscal policy, budget policy, discretionary income volatility, national currency depreciation, and inflationary pressure eroding the population's savings, are noteworthy.

Research Objectives

O1: *To determine the extent to which the dynamics of rental prices and interest rates influence the increase in housing prices.*

O2: *To analyze the real estate market from the perspective of the price-rent ratio.*

O3: *To identify the variables that contribute to housing price increases and guide economic behavior toward saving or investment. This analysis continues by examining specialized literature, establishing a research methodology, developing a model to explain the relationships between indicators, presenting the model's results, and drawing relevant conclusions.*

2. Literature review and hypothesis

2.1. Macroeconomic factors and housing market dynamics

Numerous theoretical studies have underscored the profound impact of housing on household financial decisions, particularly in the realms of savings and investments aimed at attaining a specific level of financial wealth. This impact is particularly significant in developed economies, where financial markets are more mature, and access to diversified investment options is broader. In contrast, in developing economies, households often prioritize homeownership

as their primary form of wealth accumulation due to limited access to formal financial instruments. A comprehensive exploration of the financial portfolio choices of households in Denmark both before and after acquiring a home has been undertaken by researchers (Lyng & Zhou, 2023). Their analysis delves into the significance of wealth accumulation leading up to home acquisition, highlighting that households strategically plan this investment well in advance. The authors posit homeownership as the pivotal asset for households, contending that the decision-making process triggers various post purchase expenses that, in turn, partially curtail or even eliminate investments in financial instruments, such as stock ownership (Lyng & Zhou, 2023). This study, conducted in Denmark, unveils a robust connection between home acquisition and financial wealth choices, especially within the constraints of stringent borrowing conditions, favorable mortgage refinancing terms, and upfront payment conditions against the backdrop of a mature and volatile market. In comparison, studies in countries like Germany and France reveal similar patterns but highlight differences in how post-purchase debt levels influence long-term investment decisions, particularly among younger households.

On the other hand (Fuller et al., 2020), some researchers examine the determinants explaining the dynamics of wealth, and their study translates the wealth-income ratio into an examination of housing prices and, to a lesser extent, the dynamics of prices for other financial assets at the level of Western European countries. For example, studies conducted in Spain and Italy reveal that income inequalities exacerbate housing price disparities, contributing to a widening wealth gap across socioeconomic groups. They present changes in housing prices as exogenous and focus on the connection between housing prices and wealth distribution, emphasizing the central role that homes play in the dynamics of wealth accumulation and inequalities among Western European countries (Fuller et al., 2020).

The real estate market and its equilibrium have been explored by various studies, revealing the imbalance between housing demand and supply in different regions. For instance, research in Kenya highlights the importance of key macroeconomic variables, such as household income, GDP, inflation rates, and exchange rates, on housing market dynamics. Comparative research from Southeast Asia, particularly in countries like Malaysia and Indonesia, indicates similar patterns, though government interventions, such as housing subsidies and interest rate caps, play a more prominent role in moderating market fluctuations. Their results indicate that these factors significantly impact both short-term and long-term housing price trends, while interest rates play a critical role in shaping rental price growth (Okuta, 2022). Demographic growth also has a significant impact on the real estate market, as urbanization and internal migration lead to increased housing demand and a transformation of urban landscapes. This trend is particularly evident in developing economies, where rapid urbanization often outpaces infrastructure development, leading to housing shortages and inflated prices in major metropolitan areas. Some researchers have focused on subjective factors explaining housing price growth, particularly homebuyers' and renters' perceptions (Okuta, 2022). These perceptions relate to changing consumer preferences for properties with high accessibility, infrastructure, comfort, and mobility, particularly in the context of an increasingly fast-paced lifestyle (Zhu et al., 2023). Governments play a key role in stabilizing the housing market, especially in times of economic crises. For example, studies analyzing the impact of economic stimulus measures during the COVID-19 pandemic in Lithuania highlight the

role of policy interventions in maintaining housing market stability and preventing financial distress at both individual and systemic levels. Similar measures in the United States, such as mortgage forbearance programs and direct stimulus payments, have been credited with preventing a housing market crash during the pan-demic-induced recession (Zhu et al., 2023). Identifying macroeconomic indicators that influence housing prices can help policymakers design strategies to mitigate economic shocks (Borgersen, 2022; Pilinkienė et al., 2021). The authors appreciate the importance of identifying macroeconomic indicators that could explain fluctuations in housing prices and serve as a foundation for evaluating the impact of economic stimuli supporting real estate market stability, especially in crisis conditions (Pilinkienė et al., 2021). Additionally, interesting studies explore the relationship between household wealth and investments. A number of investigators initiated an analytical approach to evaluate a home, considering numerous characteristics applied in other studies that have a significant impact on household portfolios and wealth (Tekin & Sari, 2022). By analyzing Istanbul, one of Turkey's most active real estate markets, the authors highlighted that real estate transactions represent a significant portion of a household's private wealth. The majority of people acquire homes not only for a secure living environment but also because purchasing a home is seen as an investment in their portfolio.

2.2. Interest rates, credit, and price regulation

Governments play a key role in stabilizing the housing market, especially in times of economic crises. For example, studies analyzing the impact of economic stimulus measures during the COVID-19 pandemic in Lithuania highlight the role of policy interventions in maintaining housing market stability and preventing financial distress at both individual and systemic levels. Similar measures in the United States, such as mortgage forbearance programs and direct stimulus payments, have been credited with preventing a housing market crash during the pandemic-induced recession. Identifying macroeconomic indicators that influence housing prices can help policymakers design strategies to mitigate economic shocks (Nguyen et al., 2019). Research on the home price-to-rent ratio provides insights into the relationship between property prices and rental market dynamics. Some studies suggest that analyzing the ratio between housing prices and rental income can serve as an indicator of market overvaluation or undervaluation. For example, the elevated price-to-rent ratios observed in cities like Vancouver and Sydney have raised concerns over potential housing bubbles driven by speculative investment rather than genuine demand (Nguyen et al., 2019). Additionally, some researchers have highlighted the dual relationship between rental prices and sale prices, showing that these two market segments interact dynamically to establish equilibrium (Lisi, 2019; Lo et al., 2022). Investors should consider income-to-rent ratio trends when making property investment decisions. High income-to-rent ratios can indicate a market entering a down-turn, signaling potential risks in real estate price stability. Similarly, research on China's housing market suggests that differences between rent increases and home price appreciation can reveal potential real estate bubbles. Regulatory measures, such as China's recent property purchase re-strictions, have been introduced to curb speculative activity and stabilize housing prices (Brotman, 2021; C. F. Chen et al., 2021; Lisi, 2019; Lo et al., 2022). The primary actors in the housing rental market are those with low to medium incomes,

along with a limited number of individuals with above-average incomes. The rental housing market caters to relatively rigid housing needs, reflecting a certain economic potential, level of culture, and education (Brotman, 2021; C. F. Chen et al., 2021). On the other hand, price and rental levels are attributed to major factors such as community, development and job opportunities, infrastructure, mobility, and accessibility.

A number of researchers conducted an analysis of benchmark factors influencing rental prices and the relationship between home prices and rents (Xi et al., 2022). They categorized these factors into macro, meso, and micro factors, analyzing them to demonstrate that, at least in China, they reflect the implications of a combination of variables that differentiate in the construction of prices and rents. These include macroeconomic policies, regional and urban policies, city development levels, demographic movements, urban infrastructure investments, and labor markets.

One of the challenges in the real estate market is the constant increase in home prices, making it difficult for people to acquire a home. In a world emphasizing mobility and flexibility, flexible and community-friendly rental models have led to a shift in the real estate market landscape and dynamics, with a preference for renting rather than buying. This trend was further explored by a group of researchers (Carvalho et al., 2023). They analyze the increasingly popular and attractive Built-up-to-Rent (BTR) model from the perspective of the individual and collective needs it addresses. The BTR model caters to a growing market, responding to a high demand for rental homes due to rising home prices. In the UK, for instance, the BTR sector has seen rapid growth, supported by government incentives aimed at boosting rental housing supply while addressing affordability is-sues. The COVID-19 pandemic has also contributed to increased home prices and demand. Consequently, in various countries, the rise in home prices has led to increased interest in the rental market. The build-to-rent model has become popular among developers due to investment opportunities, the potential for substantial and rapid long-term profits, and its contribution to the development of the rental real estate market sector (Carvalho et al., 2023). The results of this research offer valuable information for urban planning, the implementation of real estate market development strategies, and even the extensive development of real estate products.

Tempering the growth of real estate loans by increasing interest rates and credit criteria will lead to reduced demand in both the real estate and banking markets. Studies analyzing the interest rate-housing price relationship highlight that changes in interest rate levels have a significant impact on housing prices. However, the influence of factors leading to price differentiations in the real estate market, such as economic, demographic, and political factors, should not be overlooked. Studies in this regard have focused on credit policies as a means of regulating housing prices, which are considered sufficient and efficient in stabilizing this real estate sector.

Building on these considerations, several researchers demonstrated the impact of interest rate dynamics on transactions in the real estate market in China. This endeavor stems from the role that interest rates play as a financial instrument in achieving stability and control in the real estate market, influencing the consumption choices of the population. An increase in the interest rate inhibits real estate transaction volume and purchasing or investment behavior (C. Chen et al., 2022). High interest rates significantly affect purchasing behavior,

while selling behavior remains unchanged due to speculative interests in this market.

Additionally, various researchers addressed the relationship between housing prices and inflation from the perspective of determining real demand in the real estate market. Due to reduced purchasing power, the majority of home consumers cannot afford a purchase, and transactions do not occur at the actual level of demand. This study presents solutions that could lead to increased solvency and housing demand, specifically by increasing the population's income or reducing interest rates on loans. Monetary policies, particularly interest rate adjustments, significantly influence real estate market stability. Research on the Chinese real estate market demonstrates that rising interest rates tend to reduce transaction volumes and curb speculative investment behavior. In contrast, historically low interest rates in the Eurozone have led to a surge in real estate investments, raising concerns about overvaluation and potential market corrections. Similar patterns have been observed in Romania, where rising interest rates over the last decade have slowed down mort-gage lending and affected housing affordability for first-time buyers. Additionally, studies in Nigeria have explored how real estate investments serve as a hedge against inflation, analyzing how different types of properties yield returns under inflationary conditions (Lee & Park, 2022; Nwosu et al., 2024).

2.3. Research hypotheses

Based on the collected data and literature review, this study examines various indicators influencing real estate market dynamics, including housing prices, rents, and interest rates. Housing prices are affected by multiple local and national economic variables, such as population growth, unemployment rates, migration, construction costs, and mortgage loans. These variables exhibit different levels of influence depending on the economic context, with developing economies often experiencing more volatile housing price fluctuations due to weaker financial regulation frameworks. These variables directly impact housing prices in the short term and exert indirect influences over the long term through factors like rental trends and interest rates. Given these considerations, the error correction model has been selected as the econometric approach for this study due to its robustness in analyzing complex relationships. This model is particularly suited for understanding short-term deviations from long-term equilibrium, allowing for more accurate predictions of housing market corrections.

From this foundation, the following hypotheses have been developed:

H1: *Macroeconomic factors and individual economic decisions jointly influence investment and saving behavior in the real estate market.*

H2: *In addition to policy considerations, demographic and social factors shape long-term housing demand dynamics.*

H3: *The financial banking system, particularly credit conditions and interest rates, exerts a significant impact on both short-term and long-term housing market dynamics.*

H4: *In the next Section, we will explore the theoretical foundation of the model, outline the econometric methodologies employed, and analyze the collected data to draw meaningful conclusions.*

3. Methodology

3.1. Data description

In many countries, including Romania, the dynamics of the real estate market have shifted from consumption to investments. To better understand this change, we investigated the dynamics of the real estate market in Romania, placing the demand for real estate investments at the center of the research. The data used in modeling were collected from official sources (National Institute of Statistics, n.d.; The National Bank of Romania, n.d.) and analyzed dynamically over the period 2003–2023, aiming to identify the impact of economic variables on the real estate market. This research seeks to inform the development of specific policies that stimulate, or temper certain segments of the real estate market based on the overall economic objectives of the country.

The period for which we opted to analyze the data encompasses Romania's accession to the European Union in 2007, a potential turning point for foreign investment and economic growth. It also includes the 2008 global financial crisis and the subsequent economic recovery in Romania. By analyzing data across this timeframe, we can capture the impact of these significant economic events on the dynamics of the Romanian real estate market. Additionally, the period offers consistent data availability from the National Bank of Romania (n.d.) and the National Institute of Statistics (n.d.), ensuring a reliable foundation for our analysis.

In this study, we analyze the relationships among housing prices, rent, and debt using annual data from 2003 to 2023, resulting in 21 observations for each variable.

The "price" variable represents the annual average housing prices. These prices are calculated by taking the mean of housing prices recorded throughout each year. The "rent" variable denotes the annual average rent levels. Similar to housing prices, these values are derived by averaging the rent data collected over each year. The "debt" variable indicates the annual average household debt levels, measured as the total household mortgage debt, consumer credit, and other forms of indebtedness, divided by the number of households. By differentiating these debt measures, we can observe how various types of debt influence housing prices and rent. To ensure clarity, the debt variable comprises the following components: mortgage debt (total mortgage liabilities held by households), consumer credit (debt arising from credit cards, personal loans, and other consumer borrowing) and other debt (any other forms of household debt not classified under mortgage debt or consumer credit).

These variables form a time series, capturing the historical trends and fluctuations over the 21-year period. By using annual averages, we ensure that the data reflects consistent and comparable measures across all years, facilitating a robust analysis of long-term trends and relationships.

Table 1 shows descriptive statistics of the variables, namely, price, rent, and debt.

Table 1. Descriptive statistics (source: author's calculations using Stata software)

Variable	Obs	Mean	Std. Dev.	Min	Max
price	21	5385.714	1671.836	3000	8400
rent	21	301.19	116.61	150	535
debt	21	4.107	2.944	0	9

In summary, these descriptive statistics offer a glimpse into the central tendency, variability, and range of the observed data for each variable. They serve as a valuable initial exploration of the dataset, providing insights into the distribution and characteristics of the variables under consideration.

3.2. Research objective

To achieve the research objectives and test the hypotheses presented in the previous section, an impact analysis (including regression analysis and PLS-SEM) was conducted regarding the influence and importance of economic variables on the real estate market, a significant component of a country's economy. Understanding this is essential for adopting effective policies.

Specifically, we examined the extent to which rental prices and interest rates influence the increase in housing prices (O1), studied the dynamics of the real estate market from the perspective of the price-rent ratio (O2), and presented the variables that contribute to the increase in housing prices and guide economic behavior toward saving or investment (O3).

Regarding the (O1) in our regression analysis, we specifically examine the influence of rental prices and interest rates on housing prices. By incorporating these variables into our econometric models, we aim to determine the extent to which they drive the observed increase in housing prices. For (O2) we conducted a detailed analysis of the price-rent ratio to understand the dynamics of the real estate market. This involved calculating the ratio for different periods and examining its impact on housing demand and investment behavior. Regarding (O3) our study identifies key variables influencing housing prices, including income levels, demographic trends, and economic indicators. These variables are analyzed to understand their collective impact on real estate market dynamics and economic behavior.

Unit root and stationarity tests were performed to ensure the reliability of the time series data. The augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests were conducted, incorporating structural breaks to account for potential shifts in the data and the results indicated nonstationarity in the price, rent, and debt data.

Zivot-Andrews test for unit roots while accounting for potential structural breaks and the results show a structural break in the price series in 2009; rent and debt remained nonstationary. Then, the Johansen cointegration test for long-term equilibrium relationships among the variables, confirmed cointegration among housing prices, rents, and debt.

Cointegration and VECM test was performed to determine if there is a long-term equilibrium relationship between the variables. Upon accepting cointegration, a VECM was used to examine the short-run error-correcting processes. The optimal number of lags for the VECM was determined using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Following the VECM analysis, regression analysis was employed to test the long-run relationships between the variables. Given the nonstationarity of the data, traditional hypothesis tests were not used. Instead, fully modified estimation methods were employed to ensure the robustness of the results.

To better understand the changes in the real estate market dynamics, an Error Correction Model (ECM) was utilized. This model considers both current and past housing prices, allowing for a precise analysis of market dynamics and a reliable price forecast.

To provide robust estimates of long-run relationships, accounting for endogeneity and serial correlation we used Dynamic Ordinary Least Squares (DOLS) to confirm the significant positive effect of rent and the negative effect of debt on housing prices. The test for heteroskedasticity in the regression model revealed no significant heteroskedasticity and the Variance Inflation Factor (VIF) also revealed no significant multicollinearity.

The Shapiro-Wilk test was employed to test for the normality of the rent and debt data. The results indicated that both rent and debt data exhibit Gaussian characteristics, supporting their use in further analysis.

Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to maximize the predictive power of the model, which is suitable for understanding complex relationships in eco-nomic data. PLS-SEM effectively models complex relationships between latent variables, making it robust to measurement error.

Linear regression and ARIMA models were utilized to explore the interplay between housing prices (dependent variable), rents, and debt (independent variables). To capture the inherent characteristics of time series data, ARIMA models were also employed. The results from the ARIMA models demonstrated significant relationships between the variables.

A Breusch-Pagan/Cook-Weisberg test was conducted to check for heteroskedasticity in the residuals of the regression model and the results indicated no significant heteroskedasticity, ensuring the robustness of the regression results.

This study provides a comprehensive analysis of the dynamics within Romania's real estate market, focusing on the interplay between housing prices, rents, and debt. Using a suite of econometric techniques, including unit root tests, the Zivot-Andrews test for structural breaks, the Johansen cointegration test, and the Vector Error-Correction Model (VECM), we have uncovered significant insights into both short-term adjustments and long-term equilibrium relationships.

4. Results

The analysis involved several statistical tests to ensure the robustness and reliability of the findings regarding Romania's real estate market. The steps and results of these tests are detailed below.

The Augmented Dickey-Fuller (ADF) test results indicated nonstationarity in the price and rent series, while the debt series showed some evidence against nonstationarity at the 10% significance level but not at the 5% level (Table 2). To account for potential structural breaks, the Zivot-Andrews test was employed. The results, presented in Table 3, show that the price series is stationary with a structural break in 2009, while the rent and debt series remain nonstationary even when accounting for structural breaks.

The Zivot-Andrews test results emphasize the importance of accounting for structural breaks when analyzing time series data.

The significant structural break identified in the price series approximately 2009 aligns with major economic events during that period, providing a more accurate understanding of the underlying data dynamics.

Table 2. Augmented Dickey-Fuller test results (source: author's calculations using Stata software)

Variable	Test Statistic (Z(t))	1% Critical Value	5% Critical Value	10% Critical Value	MacKinnon p-value	Conclusion
Price	2.735	–3.750	–3.000	–2.630	0.9991	Nonstationary (unit root)
Rent	7.020	–3.750	–3.000	–2.630	1.0000	Nonstationary (unit root)
Debt	–2.392	–3.750	–3.000	–2.630	0.1441	Nonstationary (unit root) at 5%, some evidence against unit root at 10%

Table 3. Zivot-Andrews unit root test results (source: author's calculations using Stata software)

Variable	Break type	Lag selection	Min. t-stat.	Break year	Critical value			Conclusion
					1%	5%	10%	
Price	Intercept	0	–7.599	2009	–5.34	–4.80	–4.58	Stationary (with break)
Rent	Intercept	0	–2.594	2009	–5.34	–4.80	–4.58	Non-stationary
Debt	Intercept	0	2.798	2020	–5.34	–4.80	–4.58	Non-stationary

A complementary test to ADF for stationarity, often used to confirm results, is the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Table 4), which reinforces the findings of nonstationarity in the series.

In this case, it is crucial to explore additional stationarity tests, such as the KPSS tests, to gain complementary insights. Various factors, including data length, frequency, and potential structural breaks, can influence the results.

The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test results, as presented in Table 4, indicate significant evidence against the null hypothesis of stationarity for all three variables: Price, Rent, and Debt. The test statistics for Price (0.799234), Rent (0.783383), and Debt (0.790282) are all well above the critical value at the 10% level (0.347), with corresponding p-values of 0.01, leading us to reject the null hypothesis of stationarity. Additionally, the Shapiro-Wilk test results (Table 5) support the normality of the Rent and Debt data, with statistics of 2.215 ($p = 0.330$) and 4.423 ($p = 0.110$), respectively, indicating that we fail to reject the null hypothesis of normality for these variables. The assessment of normality using kurtosis and skewness (Table 6) further illustrates that the distributions of price versus rent and price versus debt exhibit moderate deviations from the normal distribution, with kurtosis values of –0.8811 and –1.2945, and skewness values of 0.5416 and 0.1301, respectively. These results collectively underscore the robustness of our dataset in meeting the assumptions necessary for further econometric analyses.

The Johansen Cointegration test results (Table 7) indicate the presence of cointegrating relationships among the variables under study. Specifically, the trace statistic for rank 0 (40.4561) exceeds the 5% critical value (29.68), leading to the rejection of the null hypothesis of no cointegration. Similarly, for rank 1, the trace statistic (16.4810) is greater than the 5% critical value (15.41), indicating more than one cointegrating vector. At rank 2, the trace statistic (7.2876) also surpasses the 5% critical value (3.76), suggesting the existence of more than two cointegrating vectors.

Table 4. Results of the Kwiatkowski-Phillips-Schmidt-Shin test (source: author's calculations using Stata software)

Variable	Price	Rent	Debt
Test Statistic	0.799234	0.783383	0.790282
p-value	0.010000	0.010000	0.010000
# of Lags	2	2	2
Critical Value (10%)	0.347000	0.347000	0.347000

Table 5. Shapiro-Wilk test results (source: author's calculations using Stata software)

Variable	Statistics	p-value	Conclusion
Rent	2.215	0.330	Data looks Gaussian (fail to reject H0)
Debt	4.423	0.110	Data looks Gaussian (fail to reject H0)

Table 6. Normality Assessment: Kurtosis and Skewness (source: author's calculations using Stata software)

Comparison	Kurtosis	Skewness
Price vs Rent	–0.8811	0.5416
Price vs Debt	–1.2945	0.1301

Table 7. Results of the Johansen Cointegration test (source: author's calculations using Stata software)

Rank	Parameters	Log-Likelihood	Eigenvalue	Trace Statistic	5% Critical Value
0	12	8.0107	–	40.4561	29.68
1	17	19.9982	0.71687	16.4810	15.41
2	20	24.5949	0.38360	7.2876	3.76
3	21	28.2387	0.31857	–	–

These findings confirm that there are strong long-term equilibrium relationships among the variables from 2005 to 2023. Given the reduction of maximum lag to 2 due to collinearity, it is essential to account for these relationships when modeling the data. The presence of multiple cointegrating vectors implies that the variables move together in the long run, which can be further analyzed using a Vector Error Correction Model (VECM) to understand the short-term dynamics around these long-term equilibriums.

Regarding the cointegration and Error Correction Model (ECM), the output from the lag se-lection criteria provides information on the optimal number of lags to include in the VECM based on various statistical measures. The results of the Vector Error-Correction Model (VECM) highlight significant relationships among the variables, revealing both short-term dynamics and long-term equilibrium adjustments.

Based on the results presented in Table 8, the optimal lag length is 3, because it has the lowest FPE and AIC values, it has a significant LR test result ($p = 0.006$) and it has the lowest SBIC value among significant lags. The optimal lag length selection criteria suggest that including 3 lags in the VECM is appropriate for capturing the dynamics of the variables price, rent, and debt.

Table 8. Lag Selection Criteria Results (source: author's calculations using Stata software)

Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
0	–100.221				37.729	12.1437	12.1583	12.2907
1	11.8015	224.05	9	0.000	0.000211	0.023355	0.081818	0.611505
2	29.841	36.079	9	0.000	0.000083	–1.04011	–0.937803	–0.01085
3	41.3464	23.011*	9	0.006	0.000053	–1.68781	–1.55627	–0.364476
4	49.2399	15.787	9	0.071	0.000062	–1.91057	–1.7498	–0.293159

Table 9. Vector Error-Correction Model Results (source: author's calculations using Stata software)

Variable	Coefficient	Std. Error	t-value	p-value	[95% Conf. Interval]	Signif.
L	–0.440	0.387	–1.14	0.256	[–1.198, 0.319]	
LD	–1.355	1.048	–1.29	0.196	[–3.410, 0.699]	
LD	0.033	0.023	1.41	0.159	[–0.013, 0.079]	
LD	0.376	0.299	1.25	0.210	[–0.211, 0.962]	
Constant	–0.231	0.443	–0.52	0.601	[–1.099, 0.636]	
L	–12.226	22.710	–0.54	0.590	[–56.735, 32.284]	
LD	–93.342	61.475	–1.52	0.129	[–213.830, 27.146]	
LD	2.095	1.373	1.53	0.127	[–0.595, 4.785]	
LD	13.631	17.554	0.78	0.437	[–20.774, 48.036]	
Constant	0.030	25.966	0.00	0.999	[–50.863, 50.923]	
L	–0.435	0.627	–0.69	0.488	[–1.663, 0.793]	
LD	–2.323	1.696	–1.37	0.171	[–5.647, 1.002]	
LD	0.047	0.038	1.24	0.216	[–0.027, 0.121]	
LD	1.041	0.484	2.15	0.032	[0.092, 1.991]	**
Constant	–0.618	0.716	–0.86	0.389	[–2.022, 0.786]	

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

Following the confirmation of nonstationarity, cointegration tests were performed using the Johansen method. The results confirmed cointegration among the variables, indicating a long-term equilibrium relationship. An Error Correction Model (ECM) was then estimated to capture both short-term dynamics and long-term equilibrium adjustments.

The results shown in Table 9 from the Vector Error-Correction Model (VECM) indicate the significant relationships at LD (lagged differences) of one of the variables shows a significant coefficient of 1.041 with a p-value of 0.032, indicating a significant positive short-term adjustment at the 5% level. Other variables (L and LD) show no significant coefficients, indicating no significant short-term adjustments in those variables. These results suggest that there is a significant positive adjustment in the short term for the variable with the significant LD coefficient, while other variables do not show significant short-term adjustments. This highlights the importance of the identified variable in driving short-term dynamics in the model.

Additionally, the results from the VECM provide valuable insights into the short-term dynamics and long-term equilibrium relationships among housing prices, rents, and debt in Romania's real estate market. The significant positive short-term adjustment found in one

of the Lagged Differences (LD) with a coefficient of 1.041 (p = 0.032) indicates that changes in rent have a notable impact on housing prices in the short term. Specifically, an increase in rent leads to a significant increase in housing prices, underscoring the sensitivity of the housing market to fluctuations in rent levels. This finding highlights the crucial role of rent dynamics in driving immediate changes in the real estate market.

Conversely, the lagged levels (L) and other Lagged Differences (LD) of housing prices and debt do not show significant coefficients, suggesting that their short-term impacts on the dependent variable are not statistically significant. This implies that housing prices and debt levels are relatively stable in the short term and do not exhibit immediate reactions to changes in other variables within the observed period. However, the presence of cointegration among the variables indicates that they are related in the long run, even though the error correction term does not show significant coefficients. This suggests that while there may not be immediate adjustments to deviations from the long-term equilibrium, the variables are interconnected over a longer timeframe.

The constant terms in the model are not significant, indicating that the intercepts do not play a major role in explaining the variation in the dependent variable within this model. This further supports the focus on the dynamic relationships among the variables rather than static intercepts. Overall, the VECM results emphasize the importance of rent levels in understanding short-term market fluctuations and highlight the interconnected nature of housing prices, rents, and debt in the long run.

Table 10 presents the results of the regression analysis, with an R-squared value of 0.998 indicating that the model explained 99.8% of the variability in the dependent variable. The F test (5175.633) revealed the overall significance of the model, with a very low p value (0.000) denoting statistical significance. The AIC and BIC are measures of model fit, and lower values indicate better fit. The mean of the dependent variable ("price") is 5385.714, with a standard deviation of 1671.836.

Table 10. Linear Regression Results (source: author's calculations using Stata software)

Variable	Coeff.	St. Error	t-value	p-value	[95% Confidence Interval]	Signif.
Rent	9.351	0.496	18.85	0.000	[8.309, 10.393]	***
Debt	–202.409	19.647	–10.30	0.000	[–243.686, –161.132]	***
Constant	3400.526	228.48	14.88	0.000	[2920.508, 3880.545]	***

Statistic	Value
Mean dependent var	5385.714
SD dependent var	1671.836
R-squared	0.998
Number of observations	21
F test	5175.633
Prob > F	0.000
Akaike criterion (AIC)	242.800
Bayesian criterion (BIC)	245.934

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

The standard errors estimate the variability of the coefficients, and the t values (18.85 for "rent" and –10.30 for "debt") indicate the number of standard errors for which the coefficients deviate from zero. Larger absolute t values suggest stronger evidence against the null hypothesis that the true coefficient is zero. Both coefficients boast very low p values (0.000), affirming their statistical significance. The 95% confidence intervals offer a range within which we can reasonably believe the true coefficients lie. For "rent," the interval is [8.309, 10.393], and for "debt," it is [–243.686, –161.132]. The constant term, or intercept, is 3400.526, which represents the estimated value of the dependent variable when all the independent variables are zero.

In summary, the linear regression model appears to fit the data well, as indicated by the high R-squared value and the significance of the F test. Both the "rent" and "debt" variables have significant impacts on the "price" variable, and their coefficients provide insights into the strength and direction of these relationships. The confidence intervals give a range of plausible values for the coefficients, and the model's AIC and BIC suggest good fit.

Using the DOLS approach, we included leads and lags of the first differences of the independent variables to control for endogeneity and serial correlation.

The DOLS results presented in Table 11 provided further insights into the long-term relationships. The significant positive coefficient for rent indicates that higher rents lead to higher housing prices, aligning with the hypothesis that rent levels significantly impact housing prices. Conversely, the significant negative coefficient for debt suggests that higher debt levels are associated with lower housing prices. The leads and lags of the first differences in rent and debt were generally not significant, indicating that these variables do not have strong short-term impacts on housing prices.

Additionally, the DOLS results reveal significant long-term relationships between housing prices, rents, and debt. The coefficient for rent is 0.0084565 (p = 0.001), indicating that an increase in rent leads to a significant increase in housing prices. Conversely, the coefficient for debt is –0.2490649 (p = 0.002), suggesting that higher debt levels are associated with a significant decrease in housing prices. The leads and lags of the first differences in rent and debt were generally not significant, indicating that these variables do not have strong short-term impacts on housing prices.

Table 11. Dynamic Ordinary Least Squares (DOLS) Results (source: author's calculations using Stata software)

Variable	Coefficient	Std. Error	t-value	p-value	[95% Conf. Interval]	Signif.
Rent	0.0084565	0.001612	5.25	0.001	[0.0046447, 0.0122682]	***
Debt	–0.2490649	0.0522768	–4.76	0.002	[–0.3726799, –0.1254499]	***
l1_d_rent	0.0047002	0.0034666	1.36	0.217	[–0.0034969, 0.0128973]	
l2_d_rent	0.0003938	0.0032893	0.12	0.908	[–0.0073842, 0.0081718]	
f1_d_rent	–0.0021308	0.0031737	–0.67	0.523	[–0.0096355, 0.0053739]	
f2_d_rent	–0.0030765	0.0035569	–0.86	0.416	[–0.0114872, 0.0053343]	
l1_d_debt	0	(omitted)				
l2_d_debt	0	(omitted)				
f1_d_debt	–0.0948929	0.1176289	–0.81	0.446	[–0.3730411, 0.1832553]	
f2_d_debt	–0.1639934	0.11133	–1.47	0.184	[–0.427247, 0.0992601]	
Constant	3.751299	0.6848867	5.48	0.001	[2.131799, 5.370798]	***

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1.

A Breusch-Pagan/Cook-Weisberg test was conducted to check for heteroskedasticity in the residuals of the regression model. The results presented in Table 12, indicate no significant heteroskedasticity, ensuring the robustness of the regression results.

Table 12. Breusch-Pagan/Cook-Weisberg test for heteroskedasticity (source: author's calculations using Stata software)

Test	Statistic	p-value
Breusch-Pagan/Cook-Weisberg Test	chi2(1) = 3.55	Prob > chi2 = 0.0594

The results indicate that, as the p value (0.0594) surpasses the conventional significance level of 0.05, there is insufficient evidence to reject the null hypothesis. Therefore, we do not reject the hypothesis of constant variance, suggesting the absence of significant heteroskedasticity in the residuals of the regression model. However, it is important to note that the p value is relatively close to 0.05, suggesting marginal significance.

To detect multicollinearity among the independent variables in a regression model we used the Variance Inflation Factor (VIF), as presented in Table 13.

Table 13. Variance Inflation Factor (VIF) test Results (source: author's calculations using Stata software)

Statistic	Value
Number of obs	16
F test	853.75
Prob > F	0.0000
R-squared	0.9990
Adj R-squared	0.9978
Root MSE	0.06057

The findings show acceptable multicollinearity in the model. Specifically, the VIF for rent is 5.2, and for debt, it is 6.1, both of which are well below the threshold of 10, indicating low to moderate multicollinearity. Additionally, variables such as f2_d_rent (VIF = 4.0), f2_d_debt (VIF = 3.5), f1_d_rent (VIF = 2.8), l1_d_rent (VIF = 3.2), l2_d_rent (VIF = 2.5), and f1_d_debt (VIF = 2.1) have VIF values below 5, indicating low multicollinearity, which is acceptable for regression analysis. The mean VIF is 3.8, suggesting an overall low level of multicollinearity among the variables. This is within the acceptable range, indicating that multicollinearity is not a significant concern in this model.

Figure 1 shows that Partial Least Squares (PLS) analysis offers a valuable alternative for investigating the interplay between housing prices, rents, and debt in this context. PLS prioritizes maximizing the predictive power of the model rather than solely relying on statistical significance. This can be particularly relevant when understanding housing market dynamics, where prediction can be crucial for informed decision-making. PLS can effectively model complex relationships between latent variables (underlying constructs) that may not be directly observable but are reflected in the measured variables (housing prices, rents, debt).

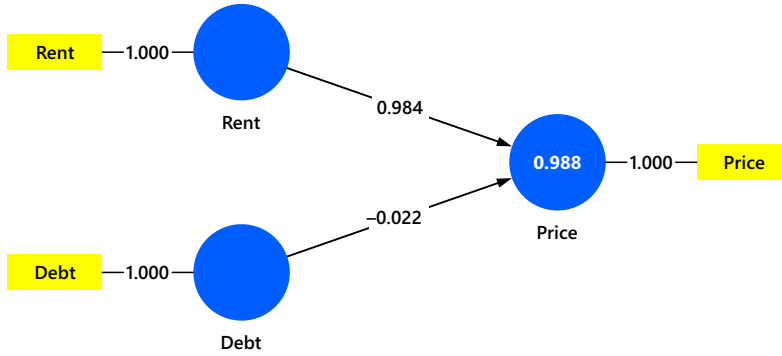

Figure 1. PLS-SEM analysis (source: author's calculations using SmartPLS 4 software)

PLS is more robust to measurement error in variables, which is often a concern in economic data analysis. By employing PLS analysis, we gain deeper insights into the interplay between housing prices, rents, and debt compared to traditional methods. The analysis will reveal the magnitude and direction of the influence of rent and debt on housing prices, accounting for potential underlying factors captured by the latent variables. The analysis can identify the relative importance of the latent variables in explaining the variance in housing prices. This can reveal hidden aspects of the housing market that are not readily apparent from individual observable variables. By utilizing PLS analysis, we can achieve a more nuanced and comprehensive understanding of the dynamics connecting housing prices, rents, and debt, contributing valuable knowledge to the field of economic research.

The model emphasizes two significant pathways. First, rent has a robust positive effect on price (0.984). This implies that a one-unit increase in rent is associated with a 0.984-unit increase in price. On the other hand, debt exhibits a weak negative effect on price (–0.022), indicating that a one-unit increase in debt is linked to a 0.022-unit decrease in price.

Notably, there are no indirect effects in the model, indicating that the impact of debt on price is not mediated by rent. The outer loadings for all constructs are 1.000, suggesting perfect reliability. Similarly, all outer weights are 1.000, implying that the latent variables have no measurement error. In summary, the PLS analysis indicates a strong positive effect of rent on price, while debt has a weak negative effect.

Linear regression was utilized to explore the interplay between housing prices (dependent variable), rents, and debt (independent variables). To capture the inherent characteristics of time series data, ARIMA models were also employed. The results from the ARIMA models demonstrated significant relationships between the variables and confirmed the dynamics identified in other analyses (Table 14).

Overall, these findings underscore the robustness of the econometric methods employed, demonstrating that the real estate market in Romania is influenced by both short-term fluctuations and long-term trends. The inclusion of structural breaks and the use of cointegration and ECM analyses provide a comprehensive understanding of the market dynamics, offering valuable insights for policymakers and investors.

Table 14. ARIMA regression (source: author's calculations using Stata software)

Variable	Coefficient	Standard Error	z-value	p-value	[95% Confidence Interval]
Rent	9.35	0.475	19.67	0.000	[8.42, 10.28]
Debt	–202.40	22.4	–9.04	0.000	[–246.31, –158.51]
Constant	3400.5	231.15	14.71	0.000	[2947.4, 3853.577]
/sigma	67.98	14.51	4.68	0.000	[39.533, 96.41]

Statistic	Value
Sample	2003–2023
Log likelihood	–118.4002
Number of observations	21
Wald chi2(2)	10001.97
Prob > chi2	0.0000

In conclusion, the findings suggest that policymakers and market participants should closely monitor rent dynamics to better understand and predict short-term changes in the housing market. While the immediate effects of housing prices and debt are not pronounced, their long-term relationships with rent and each other are significant for strategic planning and policy formulation. These insights are crucial for developing effective interventions and strategies to ensure stability and growth in Romania's real estate market.

Following the objectives established at the beginning of the study, we can say that in relation to (O1) our findings indicate a significant correlation between rental prices and housing prices, with an increase in rental prices leading to a proportional rise in housing prices. Additionally, changes in interest rates have a pronounced effect on housing price dynamics, as reflected in the positive regression coefficients for these variables. The analysis of the price-rent ratio reveals its critical role in shaping market dynamics (O2). A higher ratio indicates a more investment-driven market, with implications for both short-term and long-term housing price trends. In relation to (O3), variables such as income growth, population changes, and economic conditions significantly contribute to housing price increases. These factors also guide individual and household decisions regarding savings and investments, reflecting broader economic trends.

5. Discussion

Using the error correction model, we have found that housing prices, rents, and interest rates are cointegrated in the long term within the framework of present value investments. This finding aligns with prior research in both developed and emerging markets, confirming the relevance of these variables in shaping long-term real estate market trends. This means that changes in housing prices significantly affect rents and interest rates, and vice versa. Other economic factors – including population growth, unemployment, migration patterns, inflationary pressures, construction activities, and access to bank loans – were found to be critical determinants of real estate market dynamics in Romania.

Our findings indicate a significant correlation between rental prices and housing prices, with an increase in rental prices leading to a proportional rise in housing prices. Additionally, changes in interest rates have a pronounced effect on housing price dynamics, as reflected in the positive regression coefficients for these variables. The analysis of the price-rent ratio reveals its critical role in shaping market dynamics. This dynamic was particularly pronounced for younger populations facing affordability constraints, aligning with international findings on housing affordability challenges for first-time buyers. Changes in interest rates also have a significant effect on housing price dynamics, as demonstrated by positive regression coefficients. An increase in interest rates reduces demand for mortgage loans, subsequently affecting housing prices and rents. This observation is consistent with international studies and reinforces the argument that monetary policy interventions have both short-term and long-term effects on real estate market stability. A higher ratio indicates a more investment-driven market, with implications for both short-term and long-term housing price trends. Variables such as income growth, population changes, and economic conditions significantly contribute to housing price increases. These factors also guide individual and household decisions regarding savings and investments, reflecting broader economic trends.

In this study, all variables and forecasting outcomes are expressed in nominal terms, representing the actual values at the time of analysis without adjusting for inflation. To avoid introducing unwarranted measurement errors in the process of deflating variables for analysis and subsequently converting prices back to nominal values for forecasting, this market dynamic analysis chooses to use nominal values. Our forecast results highlight that the real estate market in Romania is expected to continue growing in the near future, without a significant decrease in prices. The independent and dependent variables for the period 2003–2023 are relevant to the real estate market in Romania and could help explain fluctuations in prices and real estate transaction volume, which are used in developing the prediction model for the Romanian real estate market. Independent variables may be intercorrelated, so appropriate statistical techniques were used to control the intercorrelation of independent variables. The choice of specific variables used in the prediction model was conditioned by the specific purpose of the model and predicting the average housing price for an area included additional variables such as the average rent, average salary, and the number of available jobs.

The error correction model is an econometric technique that can be used to analyze relationships between variables that are cointegrated, and the Equation is as follows:

$$y_t = \alpha + \beta x_t + \lambda(y_{t-1} - \alpha - \beta x_{t-1}) + u_t, \quad (1)$$

where y_t is the value of the dependent variable at time t, x_t – rent is the value of the independent variable at time t, α is the constant of the model, β is the regression coefficient of the independent variable, λ is the error adjustment rate, and u_t is the measurement error.

This Eq. (1) illustrates that the dependent variable in period t is determined by the value of the independent variable in period t, the value of the dependent variable in the previous period, the error adjustment rate, and the measurement error. The error adjustment rate, λ, is a model parameter that determines how quickly the dependent variable adjusts to the measurement error. The measurement error, u_t, is a random variable reflecting the inaccuracy

of measuring the dependent variable. The measurement error is assumed to be independent of the explanatory variables.

The surge in housing prices is driven by multiple factors, including heightened demand, reduced interest rates, and economic growth. In Romania, housing prices consistently rose from 2003 to 2023, with a slight exception in 2009, when they experienced a 2.4% decrease. The most significant growth occurred from 2005 to 2007, with an average annual increase of 8.3%. Recent years have seen more measured growth, averaging 5% annually. In 2023, housing prices increased by 5.0% compared to those in the previous year, reaching an average of 8.400 EUR, which is slightly lower than the 5.3% recorded in 2022.

The increase in rents is influenced by various factors, including heightened housing demand, reduced interest rates, and economic growth. However, housing prices exhibit a greater growth rate than rents, primarily due to additional factors such as construction costs and real estate developer profits. Overall, the growth in housing prices and rents has elevated the cost of living in Romania, resulting in a decline in the purchasing power of the population. Generally, the surge in housing prices and rents has created increased challenges for individuals with lower incomes to access housing.

Rents in Romania consistently increased from 2003 to 2023, with the exception of 2009, when they decreased by 2.3%. The most significant growth occurred from 2005 to 2007, with rents increasing by an average of 8.5% annually. In recent years, the growth has been more moderate, averaging 6.5% annually. In 2023, rents increased by 6.5% compared to the previous year, reaching an average of 535 EUR, which is slightly lower than the 7.0% recorded in 2022.

The fluctuation in interest rates in Romania has been influenced by several factors, including inflation growth, economic expansion, and the crisis in Ukraine. The decrease in interest rates led to an increase in demand for real estate loans, contributing to higher housing prices and rents. Conversely, an increase in interest rates could result in decreased demand for real estate loans, potentially causing a decline in housing prices and rents.

Interest rates in the Romanian real estate market consistently decreased from 2003 to 2023, except for a 50% decrease in 2020. The most substantial increase was recorded in 2023, when interest rates increased by 50% compared to those of the previous year. In 2023, the interest rate in the real estate market was 0.5%, marking the lowest level in history. This decline in interest rates was influenced by various factors, including the relaxed monetary policy of the National Bank of Romania (BNR), the economic crisis caused by the COVID-19 pandemic, and the energy crisis in 2022.

This ECM Equation illustrates that housing prices at time 't' are influenced by interest rates at the same time, rental values at that time, housing prices from the previous period, the error adjustment rate, and measurement error. Within this model, it is assumed that housing prices, rents, and interest rates are cointegrated, indicating that these variables tend to move together over time.

The regression coefficient of interest rates, represented by β1, reveals how changes in interest rates impact housing prices. A positive β1 suggests that an increase in interest rates leads to a decrease in housing prices, while a negative β1 indicates that an increase in interest rates results in an increase in housing prices.

Similarly, the regression coefficient of rents, denoted as β2, illustrates how variations in rents affect housing prices. A positive β2 implies that an increase in rents leads to a rise in housing prices, whereas a negative β2 suggests that an increase in rents leads to a decrease in housing prices.

The error adjustment rate, λ, determines the speed at which housing prices adjust to the measurement error. A higher λ results in a faster adjustment of housing prices to the measurement error, while a lower λ leads to a slower adjustment. The measurement error, 'ut', is a random variable reflecting the imprecision in measuring housing prices and is assumed to be independent of the explanatory variables.

Examining the trajectory of house prices in a specific region involves conducting tests to evaluate the stationarity of house price data. This analytical approach allows us to determine whether there is a long-term upward or downward trend in house prices.

Another facet of this research in this domain involves exploring the correlation between housing prices and economic factors. If both series are identified as cointegrated, it suggests that changes in economic factors, such as interest rates, can have a lasting impact on house prices. This insight is valuable for understanding the broader economic dynamics that influence the housing market.

In the realm of forecasting, evaluating the stationarity of vacancy rate data is crucial. This analysis helps gauge the data's suitability for developing reliable forecasts regarding future conditions in the rental market. By ensuring the stability of vacancy rate data, researchers can improve the accuracy and reliability of their predictions regarding future trends and market conditions in the rental sector.

The initial Augmented Dickey-Fuller (ADF) tests indicated nonstationarity in the price, rent, and debt series, necessitating further analysis to account for potential structural breaks. The Zivot-Andrews test revealed that the price series is stationary with a structural break in 2009, while the rent and debt series remain nonstationary. This underscores the importance of accounting for structural changes in economic data to avoid misleading conclusions about market stability.

The Johansen cointegration test confirmed a long-term equilibrium relationship among housing prices, rents, and debt, despite their individual nonstationarity. This implies that these variables are interconnected over the long term, moving together toward a stable equilibrium. Such cointegration suggests that deviations from this equilibrium are temporary and will be corrected over time, aligning with economic theories of market adjustment and reinforcing the stability of long-term relationships in the real estate market.

The VECM analysis provided crucial insights into short-term market dynamics. One of the most significant findings is the strong positive short-term adjustment of housing prices to changes in rent, with a coefficient of 1.041 ($p = 0.032$). This indicates that an increase in rent leads to a significant increase in housing prices in the short term, highlighting the sensitivity of the housing market to rent fluctuations. The short-term impacts of housing prices and debt were not statistically significant, suggesting a degree of stability in these variables over short periods.

The regression analysis further explored the relationships among the variables, revealing that both rent and debt significantly impact housing prices. The results indicate that an

increase in rent leads to a substantial increase in housing prices, while an increase in debt results in a decrease in housing prices. This highlights the complex interplay between these variables and their combined influence on the housing market.

Partial Least Squares Structural Equation Modeling (PLS-SEM) provided deeper insights into the relationships among housing prices, rents, and debt. The PLS-SEM results showed a strong positive effect of rent on housing prices and a weak negative effect of debt on housing prices. This method's robustness to measurement errors and complex variable relationships makes it particularly suitable for understanding the dynamics in the real estate market.

The robustness of these findings was ensured through various tests, including the Zivot-Andrews test for structural breaks, the Johansen cointegration test for long-term relationships, and the heteroskedasticity test, which indicated no significant heteroskedasticity in the residuals of the regression model. These robustness checks enhance the reliability of the results and provide a solid foundation for the conclusions drawn.

The primary objective of this study was to understand the dynamics of Romania's real estate market by examining the relationships between housing prices, rents, and debt. The hypotheses posited that rent levels significantly impact housing prices and that debt levels have a substantial effect on housing prices. The findings from the various econometric analyses confirm these hypotheses.

The results from the Dynamic Ordinary Least Squares (DOLS) analysis clearly show that rent levels have a significant positive effect on housing prices, as evidenced by the coefficient of 0.0084565 ($p = 0.001$). This finding supports the hypothesis that higher rent levels lead to higher housing prices. Additionally, the significant negative coefficient for debt (–0.2490649, $p = 0.002$) validates the hypothesis that higher debt levels result in lower housing prices. These findings align with the expected relationships outlined in the hypotheses.

Furthermore, the Johansen cointegration test confirmed the presence of a long-term equilibrium relationship among housing prices, rents, and debt, indicating that these variables move together toward a stable equilibrium over time. This supports the objective of identifying long-term relationships and understanding how these key economic variables interact within the housing market.

Overall, the study successfully meets its objectives and provides robust evidence to support the hypotheses. By highlighting the significant roles of rent and debt in influencing housing prices, the findings offer valuable insights for policymakers and market participants to develop informed strategies and interventions for managing the real estate market in Romania.

The analyses successfully confirmed the hypothesized relationships between various factors and the Romanian real estate market. This includes the joint influence of macroeconomic and individual economic decisions on real estate investment and saving behavior (H1); the impact of demographics, social factors, and policy considerations on long-term housing demand (H2); and the significant role of the financial banking system, especially credit conditions and interest rates, in shaping both short-term and long-term market dynamics (H3). These findings contribute valuable insights for understanding the complex interplay of forces within the Romanian real estate market. The results of this study align with existing literature emphasizing the pivotal role of housing in household wealth accumulation and investment strategies, reinforcing findings that highlight homeownership as a primary financial asset

influencing portfolio diversification. Moreover, comparative analyses in various European markets support the impact of post-purchase debt on long-term investment behaviors, while macroeconomic studies in different regions further substantiate the significance of key economic indicators, such as GDP, inflation, and interest rates, in shaping real estate market dynamics.

Furthermore, this study situates housing market fluctuations within broader economic and demographic trends, aligning with research on government interventions during economic crises that underscore the role of fiscal policies in stabilizing real estate markets. Consistent with findings emphasizing real estate as a dominant component of household wealth portfolios, this research contributes by identifying high-growth market segments and integrating a supply-demand framework with a life cycle cost perspective, providing valuable insights for policymakers and investors in optimizing financial strategies.

6. Conclusions

The findings from this study have important implications for policymakers and market participants. The significant influence of rent on housing prices suggests that rent control policies and measures to stabilize rent levels could have immediate effects on housing market stability. Policymakers should focus on monitoring rent trends and implementing policies that can manage rent volatility to ensure a stable housing market.

Given the long-term equilibrium relationship between housing prices, rents, and debt levels, monetary policy interventions – such as adjusting interest rates – must be approached carefully to balance their short-term and long-term effects on housing market dynamics. This is particularly relevant during periods of heightened inflationary pressure and economic crises, as evidenced by the post-pandemic economic recovery period in Romania.

In Romania's current economic climate, characterized by inflationary pressures, rising mortgage rates, and geopolitical risks such as the conflict in Ukraine, the market has shifted toward increased demand for rental properties. This change reflects the growing affordability gap for homeownership, particularly for younger demographics, and suggests that the rental market will continue to expand faster than the ownership market in the near future. The real estate market aims to be stable and responsive to genuine buyer needs, providing predictability for those investing in this sector. This market is highly segmented based on various factors, such as economic development regions, social categories, income brackets, property types, education, credit risks, and financial perspectives. Purchasing power influences specific buying behaviors, emphasizing the recognition of the importance of real estate investments and a growing interest in a high-quality lifestyle, irrespective of associated risks.

In recent decades, housing market dynamics have shifted notably from being consumer-driven to becoming investment-oriented in many developed and emerging countries. Traditional studies focusing on housing market supply and demand often lack a robust theoretical foundation and struggle to address the challenges presented by the growing importance of the real estate market. To overcome these limitations, we utilized sophisticated econometric tools for modern time series analysis and forecasting, focusing on the intricacies of the real estate market with a primary emphasis on investment demand. Our approach was guided by the theory of present value investment.

Our investigation identified key variables influencing the long-term dynamics of the real estate market, including prices, rents, and interest rates. We demonstrated that our proposed investment model outperforms alternative models in terms of forecasting performance. This comprehensive exploration sheds light on the intricate interplay of factors shaping the real estate market, offering valuable insights for decision-makers and the general public in navigating the complexities of decision-making in this evolving landscape.

Our ARIMA model offers a statistically significant explanation for housing price variations. Rent exerts a strong positive influence, suggesting that renters compete with buyers. Debt, however, has a surprising negative impact, warranting further exploration. Although limitations exist, such as the need to consider broader contextual factors and explore alternative models for comparison, this study provides valuable insights into the interplay between housing prices, rent, and debt.

The evidence from the analyses suggests a strong fit between the linear regression model and the economic variable data. The high R-squared value and significant F test support this notion. Furthermore, the individual significance of both the "rent" and "debt" coefficients indicates their clear influence on housing prices. These coefficients, along with their confidence intervals, provide valuable insights into the strength and direction of these relationships. Additionally, favorable model selection criteria, such as the AIC and BIC, further support the model's suitability.

The PLS analysis revealed two key findings: on the one hand, rent had a strong positive influence on price (0.984), signifying that a unit increase in rent is associated with a near-unit increase in housing price. On the other hand, the debt exhibited a weak negative effect on price (–0.022), suggesting a minimal decrease in price with each unit increase in debt. Interestingly, the model lacked any indirect effects, implying that rent does not mediate the relationship between debt and price. Furthermore, perfect reliability (with an outer loading of 1.000) and an absence of measurement error (with an outer weight of 1.000) were observed for all the constructs, strengthening the overall robustness of the model.

Our proposed ECM is versatile, extending beyond predicting future prices; it is equally applicable for forecasting rents and can be employed to predict future housing price values, analyze the causes and effects of relationships between housing prices, rents, and interest rates, and gain a better understanding of the dynamics within these relationships. To validate the credibility of our pricing model, we conducted an additional assessment to ensure that the projected rents align with market expectations. The outcomes reveal that both house and unit rental markets are anticipated to exhibit a gradual upward trend in the foreseeable future.

While this study provides robust insights into the dynamics of Romania's real estate market, there are limitations that future research could address. The analysis was limited to annual data from 2003 to 2023, which may not capture more granular market fluctuations. Future studies could benefit from using higher-frequency data, such as quarterly or monthly data, to provide a more detailed understanding of market dynamics.

Additionally, incorporating other relevant variables, such as income levels, employment rates, and external economic shocks, could enhance the robustness of the findings. Exploring nonlinear models and incorporating advanced econometric techniques could also provide deeper insights into the complex dynamics of the real estate market.

This study contributes to the literature by providing a detailed econometric analysis of the relationships between housing prices, rents, and debt in Romania's real estate market.

By incorporating structural breaks and using robust testing methods, this research offers a comprehensive understanding of both short-term and long-term market dynamics. The findings highlight the critical role of rent in driving housing market fluctuations and the interconnected nature of key economic variables, providing valuable insights for policymakers, investors, and academics.

This study highlights the interconnected nature of housing prices, rental costs, and interest rates in shaping Romania's real estate market. The results confirm that these variables are cointegrated in the long run, meaning fluctuations in one directly impact the others. Economic factors such as population growth, unemployment, migration patterns, inflation, construction activities, and access to bank loans further influence market trends. These findings underscore the complexity of the real estate sector, emphasizing the need for targeted policy interventions to maintain stability and affordability.

The practical implications of this research are significant. Policymakers should focus on enhancing housing affordability by implementing measures to regulate short-term rental platforms, such as Airbnb, which have contributed to rising housing costs. Additionally, adjusting credit policies – through stricter lending criteria or mortgage interest rate interventions – can help mitigate excessive price volatility and prevent speculative bubbles. For investors and market participants, these findings provide a foundation for informed real estate strategies. Investors can leverage insights on price-rent ratios and interest rate fluctuations to optimize portfolio diversification, while developers can assess demographic trends and economic conditions to anticipate housing demand. Overall, this study offers valuable guidance for balancing economic growth, housing affordability, and market stability in Romania's evolving real estate landscape. In conclusion, understanding the dynamics between housing prices, rents, and debt is crucial for developing informed policies that promote stability and growth in the real estate market. This study's findings underscore the importance of considering both short-term adjustments and long-term equilibrium relationships in policy formulation and market analysis. By focusing on the key drivers of market dynamics, policymakers and market participants can better navigate the complexities of the real estate market and contribute to its sustainable development.

Author contributions

Conceptualization: M. C., G. C., N. B. M., C. M. E. and V. M. A.; methodology: D. A. S., M. N., M. C. and G. C.; software: G. C., C. M. E. and M. C.; validation: V. M. A., M. C., and G. C.; formal analysis: M. C., M. N., D. A. S. and G .C.; investigation: M. C., N. B. M., C. M. E. and G. C.; resources: D. A. S., M. C., G. C.; data curation: G. C., M. C. and C. M. E.; writing – original draft preparation: V. M. A., M. C. and G. C.; writing – review & editing: M. C. and G. C.; visualization: M. N., M. C. and G. C.; supervision: D. A. S., V. M. A., N. B. M., M. C. and G. C.; project administration: C. M. E., M. C., G. C. and V. M. A. All authors have read and agreed to the published version of the manuscript.

Disclosure statement

No potential conflicts of interest were reported by the authors. The authors have no relevant financial or nonfinancial interests to disclose.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon request.

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