

**UNIVERSITY OF
INSURANCE AND FINANCE**

**ABSTRACT
of
DOCTORAL
DISSERTATION**

ON THE TOPIC:

**DWELLINGS
REVALORIZATION IN
BULGARIA: FACTORS,
MODELS, TRENDS**

FOR THE AWARD OF THE SCIENTIFIC DEGREE

„DOCTOR OF SCIENCES“

IN PROFESSIONAL FIELD 3.8 „ECONOMICS“

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The dissertation comprises 390 pages, of which 328 pages of main text and 30 pages of appendices. The main text contains 42 figures and 47 tables. The literature used covers a total of 316 sources, including 47 in Cyrillic and 269 in Latin script.

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1. GENERAL CHARACTERISTICS OF THE DISSERTATION

1.1. Relevance of the study

Bulgaria's accession to the eurozone on 1 January 2026 completes a long process of monetary convergence that began with the introduction of the currency board in 1997. This historic moment places the country in a unique position to study the effects of monetary integration on the housing market – a position that combines the characteristics of a small open economy with nearly three decades of fixed exchange rates against the German mark and the euro. Although the literature offers numerous analyses of housing markets (Pagourtzi et al., 2003) in established eurozone member states, along with individual studies of the post-communist transformation of real estate in Eastern Europe, there remains a significant gap in understanding how housing prices are determined during the transition from a long-standing currency-board regime to eurozone membership.

Existing studies on real estate prices in Central and Eastern European countries (Marinković et al., 2024; Idirizov, 2025) typically focus either on the period of post-communist privatization and liberalization (Egert & Mihaljek, 2007), or on the effects of EU accession (Ciarlone, 2015), or – for the few countries that adopted the euro – on the consequences of monetary integration (Dandashly & Verdun, 2021). A systematic analysis of a broad spectrum of housing-price determinants in the context of prolonged monetary convergence preceding formal membership is lacking. Bulgaria represents a unique case for such an analysis. Unlike countries such as Slovakia, Estonia or Lithuania, which adopted the euro after relatively short preparation periods, Bulgaria maintained a fixed exchange rate to the euro – initially through the peg to the German mark in 1997 – for almost thirty years before entering the eurozone. This long transitional state creates a specific institutional environment in which expectations of currency stability are already priced in ex ante, while the institutional mechanisms of the monetary union are not yet functioning. This raises the question of whether, in such a configuration, housing prices move according to determinants typical of transition economies, of countries undergoing convergence, or already reflect dynamics typical of eurozone members. Second, the question arises of whether accession expectations generate a pre-emptive increase in the house price index (Liu et al., 2024), with fundamental factors such as GDP and wages lagging behind price growth. Third, we examine the possibility of an independent trajectory of house price dynamics based on the convergence of household wealth in the EU Member States in general and the euro area in particular. The search for answers to these questions defines the research problem addressed in this study. The study focuses on identifying the key factors driving house price growth in Bulgaria over the period 2015–2025, which covers both the phase of intensive preparation for euro area membership and the pandemic shock that had a strong negative effect on the Bulgarian population, followed by the approval of euro area membership through the publication of the Convergence Report on 4 June 2025

(European Commission, 2025). From a theoretical perspective, this period represents a natural experiment for studying the stability of determinants under changing institutional regimes. From a practical perspective, understanding these factors (Yordanova & Hristozov, 2025) has direct implications for the implementation of macroprudential policy and for monitoring financial stability under a new exchange rate regime after the introduction of a new currency (Atanasov et al., 2017).

The central research gap addressed in this study is the absence of empirical models that systematically test which of the many potential determinants of housing prices retain explanatory power under conditions of prolonged monetary convergence. Although studies of housing markets in individual Eastern European countries exist, they rarely apply a staged approach to selecting factors from a broad spectrum of variables, and even more rarely cover the period immediately before and during eurozone accession. This methodological gap is particularly important because it limits the ability of policymakers and central bankers to identify the benchmark indicators needed to monitor the housing market under changing institutional conditions. Eurozone accession may act as a psychological factor with a strong influence on buyers and sellers in the housing market (Visković & Čipčić, 2025). Comparisons of housing prices before and after eurozone accession support the existence of an accession effect, which in turn supports the convergence process, including the accumulation of household wealth. The methodological challenge is to explain how, under conditions of macroeconomic stability and a declining HICP consistent with the Maastricht convergence criteria, a sustained increase in the *ad valorem* measure of housing prices is observed.

In search of an explanation for this process, building on the methodological frameworks of classical models that assess a limited number of macroeconomic variables, the aim is to broaden the scope of the econometric assessment to as wide a spectrum of determinants as possible, related to housing construction, monitored by statistical institutions and banks, for which continuous data are available for the relevant period.

Such an approach allows the identification and quantification of the key factors that explain the accelerating growth of housing prices in Bulgaria over the period 2015–2025 under conditions of prolonged monetary convergence, using a methodological approach for selecting from a broad spectrum of macroeconomic, financial, demographic and sectoral variables.

1.2. Object and subject of the study

Based on the relevance outlined above, the **object** of the present study is housing in Bulgaria as a foundation of household wealth, an accelerator of growth and an indicator of societal well-being. The **subject** of the dissertation is defined as the revalorization of housing in Bulgaria over the period 2015–2025 through the lens of econometric modeling of price adjustments and the factors accelerating

growth.

1.3. Main research thesis and working hypotheses

The leading **research thesis (H)** states that, in the process of the country's cohesion and catching-up economic growth, Bulgaria, as an EU member state, achieves a revalorization of housing, as measured by the general house price index and its constituent sub-indices, which is due to the influence of factors unique to the country, reinforced by the accelerating effect of the country's accession to the Eurozone.

In view of the object, subject and leading research thesis thus formulated, the following working hypotheses are put forward for testing and proof:

Working hypothesis H1. Through a review of scientific research and academic literature in indexed scientific periodicals, it is possible to establish both groupings of determinants of house-price dynamics with global validity and predictors with national and spatial-regional manifestations, whose direction and strength of influence are determined through evolutionarily upgraded methodological instruments.

Working hypothesis H2. The assessment of the revalorization of housing prices in Bulgaria, measured through the general house price index and its sub-indices for existing and new dwellings, by means of descriptive statistics indicators and regression-correlation modeling, derives relationships with a diverse metric, describing a sustained growth process with accumulated positive effects from EU membership and the country's accession to the Eurozone as of 1.1.2026.

Working hypothesis H3. The trend of house price increases in Bulgaria has its cohesive context in the EU27 environment, but also a strictly national set of combinations of impacts of stationary determinants with statistically significant impacts, supported by the inertial influence of the seasonal and/or autoregressive component in the derived ARIMAX models, which accelerate the revaluation before and during the country's approval for admission to the Eurozone.

1.4. Aim and tasks of the study

The main aim of the dissertation is to study the process of revalorization of housing in Bulgaria as an EU member state, through the analysis and assessment of growth factors, modeling the dynamics of change and the acceleration of price adjustments. The time frame of 2015-2025 ends with the country's accession to the Eurozone and corresponds to the entry into force of Implementing Regulation (EU) No. 2025/1182 .

On the basis of the working hypotheses, leading thesis and main aim thus formulated, the dissertation sets out to solve the following main **research tasks**:

First research task. To identify, based on a review of the academic literature in indexed scientific periodicals, globally influential factors on housing

prices, as well as the evolution of the studies conducted in terms of their theoretical foundation, methodological context, practical-applied results and territorial validation, incl. with a focus on Bulgaria. The solution of this task is the focus of the study in Chapter One.

Second research task. To identify the widest possible range of determinants of housing revalorization in Bulgaria and, on the basis of their grouping, to conduct a primary regression-correlation analysis and modeling of their influence on the triumvirate of housing-price measures in Bulgaria – the general house price index; the price index of existing dwellings, as well as the price index of newly built dwellings, supplemented by an analysis using the tools of descriptive statistics. The solution of this task is the focus of the study in Chapter Two.

Third research task. Through the application of stationarity tests, to carry out a selection of the determinants of housing-price revalorization in Bulgaria, whereby statistical and econometric methods are used to determine those factors that are most suitable for the statistical explanation of the growth of prices on the Bulgarian housing market, measured against the three main indices. The solution of this task is the focus of the study in Chapter Three.

1.5. Methodology of the study

To achieve the stated aim and tasks, the dissertation applies the methods of induction and deduction, comparative analysis, grouping of predictors, descriptive statistics, regression-correlation modeling, ADF, PP & KPSS stationarity tests, autoregressive integrated moving average models with exogenous predictors (ARIMAX), Ljung–Box, Shapiro–Wilk, Kolmogorov–Smirnov and ARCH LM tests, and diagnostic checks for normality and model stability.

1.6. Scope and limitations of the study

Structured in this way, the dissertation research has several inherent limitations. First, the analysis uses quarterly data for a ten-year period (2015–2025), resulting in 41 observations – sufficient for a statistically valid estimate, but conservative with respect to capturing the high-frequency dynamics of factors for which market-price data are generated daily, weekly or monthly. Second, the focus is on nationally aggregated data, which conceal regional differences in housing markets, where the capital agglomeration typically exerts a leading influence on national trends. Third, the econometric procedure requires the exclusion of certain predictors from the final model due to methodological constraints such as non-stationarity, among others. These variables are examined separately in the interpretative part of the dissertation in order to provide a fuller picture of the factors affecting the General House Price Index (GHPI), which is published quarterly by the National Statistical Institute of Bulgaria and Eurostat and covers transactions with both new and existing dwellings. Fourth, the

observation period includes only a short interval following the publication of the convergence report recommending Bulgaria's accession to the eurozone on 1 January 2026, which limits the ability to assess the long-term effects of monetary integration. The limitations noted do not preclude further consideration of the possible effects of structural changes in the economic environment, regulatory changes and extraordinary events that could affect the projected results. Examples include the update of housing tax assessments in Bulgaria, supported by the National Association of Municipalities in the Republic of Bulgaria (NAMRB), and the introduction of a progressive scale for second and subsequent dwellings owned by households.

2. SCOPE, STRUCTURE AND CONTENT OF THE DISSERTATION

2.1. Scope and scientific metrics of the dissertation

The dissertation comprises 390 pages, of which 328 pages of main text and 30 pages of appendices. The main text contains 42 figures and 47 tables. The literature used covers a total of 316 sources, including 47 in Cyrillic and 269 in Latin script.

2.2. Structure of the dissertation

The study is structured following the classical three-chapter approach. After the introduction, which sets out the relevance of the study, the research gaps, the thesis, the aim, the hypotheses, the tasks and the limitations, Chapter One conducts a critical assessment of the factors for housing revalorization, with an emphasis on the theoretical and applied findings reflected in leading indexed economic journals. The critical assessment is developed at a global level in order to capture trends in thematic housing-price studies, as well as specifically for the Bulgarian housing market, where, through a chronological selection of indexed studies, the evolution in the interpretation of the problem by representatives of the national scientific school is traced.

In Chapter Two, based on an analytical review of contemporary studies on housing-price determinants, a rationale for their grouping is presented, and a primary regression-correlation analysis and modeling is carried out, with a parallel assessment through the tools of descriptive statistics of their influence on the triumvirate of housing-price measures in Bulgaria – the general house price index (GHPI), the price index of existing dwellings (HPIED), and the price index of newly built dwellings (HPIND). Emphasis is also placed on international trends in the housing sector at EU27 level and Bulgaria's place within it.

In chapter three, the collection and grouping of national data on predictors allows to justify the methodological approach and to specify a basic model of autoregressive integrated moving average with exogenous predictors (ARIMAX) for estimating the revaluation of housing in Bulgaria. The results of the analysis are presented sequentially, including the statistical characteristics of the ARIMAX models for the three indices, accompanied by the estimates of the individual factors. The findings are discussed in a critical context in light of the theoretical expectations, the institutional aspect and the financial and economic impacts of the predictors selected in the models on the three housing indices. Alternative models are tested to prove the optimal characteristics of the selected ARIMAX models in terms of the parameters and errors that describe the change in the change in the revaluation of housing prices in Bulgaria.

The conclusion summarizes the main findings, outlines the implications of the results for institutional policy development, and proposes directions for future research. In this way, the present dissertation affirms the aspiration to position the Bulgarian housing market within the spectrum of moderate price growth

(consistent with EU27), dominated by a nationally distinct price dynamic that transforms the effects of eurozone accession into accelerators of housing revalorization. This leads to an increase in household wealth as the principal economic agent and potentially broadens the tax base for local taxes and fees under the Local Taxes and Fees Act (LTFA).

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3. SYNTHESIZED PRESENTATION OF THE DISSERTATION

CHAPTER ONE. CRITICAL ASSESSMENT OF THE FACTORS FOR HOUSING REVALORIZATION – THEORETICAL AND APPLIED FINDINGS

The evolution of contemporary understanding of wealth as a central economic category can be traced back to Adam Smith's seminal work „The Wealth of Nations“ (1776). In it, the aforementioned financial-economic category is introduced not merely as a static quantity, but as a dynamic variable whose changes are inextricably linked to the behavior of the main economic agents – the state, firms and households.

In turn, national wealth is a „cumulative expression of the wealth held by the main economic agents“ (Brusarski, Zahariev & Manliev, 2015). Within this framework, it is structured into three layers from the standpoint of the economic agents (see Fig. 1) that actively participate in the circulation of monetary flows in the national economy. The first layer comprises the wealth of the government, represented by the recorded and unrecorded property of the state (distinguishing between public and private state property) and of the municipalities (distinguishing between public and private municipal property), and the effects of their integrated regional development (Zahariev et al., 2020). The second layer includes corporate wealth and the property of firms. From the standpoint of property law, this wealth belongs to the legal entity, while the holders of shares or units in a limited liability company become mediated owners of that wealth (Nenkov, 2015). The third layer is the wealth and property of households (Radulova, 2011), in whose structure dwellings, regulated land, agricultural land and similar assets invariably occupy a leading place as own real assets.¹

Within this classification, dwellings find their natural place in the third component of the five-component systematization of national wealth by elements, while in the structure of wealth by economic agent they are simultaneously present in the sphere of corporate property (residential construction and investment properties), in household wealth (main dwelling and additional property), and in the sphere of state/municipal property as housing stock with private disposal rights for accommodation, rental and sale (NSI, 2022c). To the extent that the housing stock (see Fig. 2) represents a significant and growing share component in the property wealth of households and in the structure of national wealth as a whole, the study of the factors determining its monetary equivalent acquires independent analytical significance.

¹ Note: The sources listed correspond to the bibliography in the dissertation (pp. 359-386).

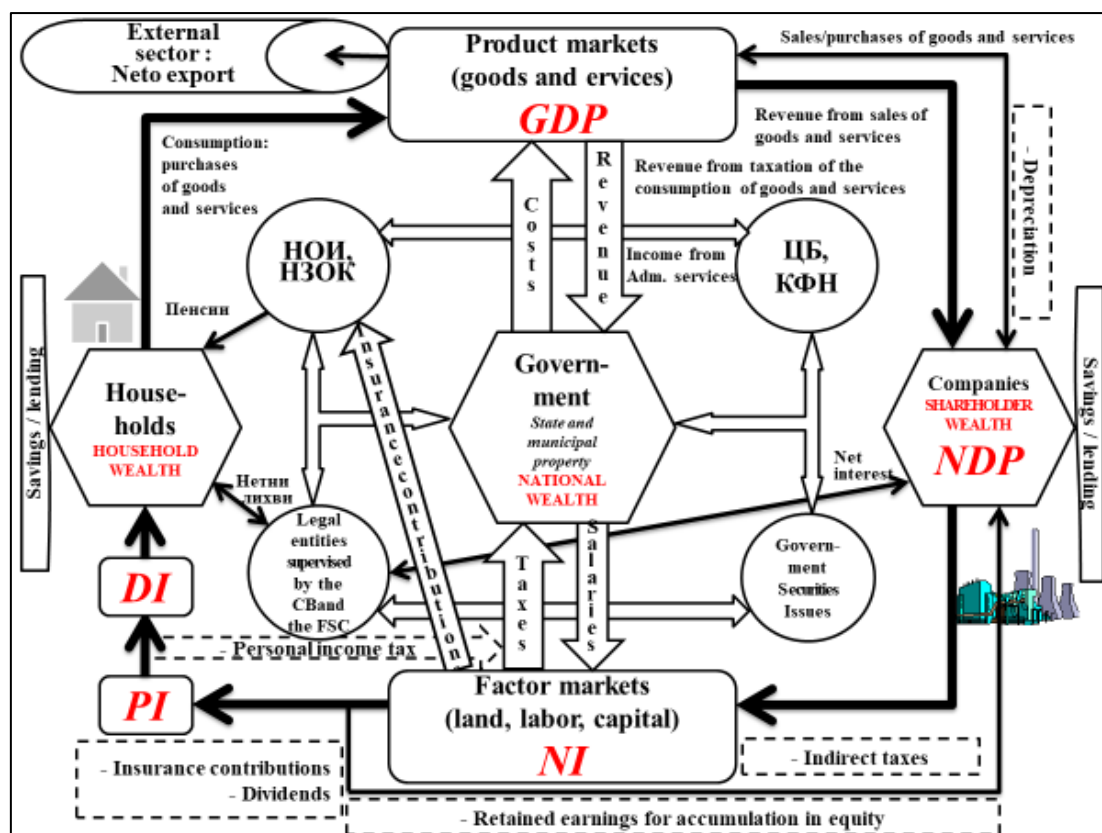


Figure 1. Wealth and GDP in the circulation of monetary flows in the national economy

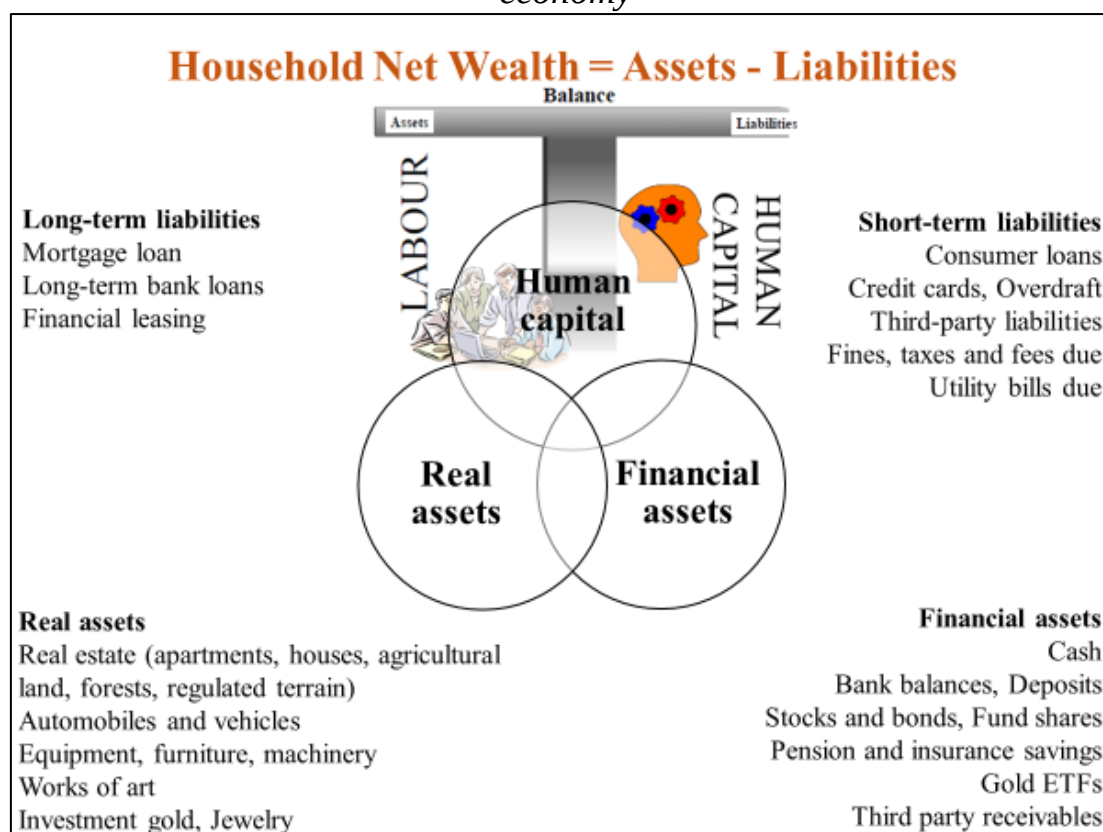


Figure 2. Extended tripartite model of household wealth as the principal economic agent

On this basis, the following more important substantive points and results are derived within the presentation of Chapter One:

First. A thorough review of the academic literature reveals that price fluctuations in real estate are formed predominantly by the complex interaction of interest-rate levels, the dynamics of demand and supply, credit conditions and broader economic factors, amid significant regional disparity. None of these factors alone is sufficient to explain the observed price dynamics. Understanding requires integrated analytical frameworks capable of capturing the interactions and feedback loops between the monetary, credit and real sectors of the economy.

Second. Interest-rate levels stand out as a key factor, displaying a clearly inverse relationship with housing prices. Lower interest rates stimulate housing demand by reducing financing costs, thereby raising prices, while higher interest rates suppress demand. However, this sensitivity is not uniform across markets: it is stronger in areas with inelastic supply and high income, and varies depending on the structure of the mortgage market and the policy regime. The effects of interest-rate levels can be lagged and non-linear, reflecting the complex transmission mechanisms in housing finance systems.

Third. The supply response profoundly mitigates price instability. Regions with elastic housing supply experience more moderate price surges following demand shocks, while regions with inelastic supply face amplified instability. Demand-side factors, including population growth, income levels, migration and employment, steadily drive price growth, interacting dynamically with supply constraints in shaping local market outcomes. Empirical findings highlight non-linear and asymmetric reactions, whereby housing markets respond more strongly to positive demand shocks than to negative ones, underscoring the role of behavioral and institutional inertial constraints.

Fourth. Credit availability, mortgage conditions and lending standards significantly shape housing-market cycles, often amplifying cyclical upswings and downswings. Shocks to credit supply often exert a more immediate impact on housing prices than shocks arising from monetary-policy adjustments themselves, pointing to the decisive role of financial intermediation and the characteristics of mortgage markets. Stricter lending standards can moderate price growth, while looser credit conditions can fuel overvaluation and instability. The two-way causal relationship between credit and housing prices complicates empirical identification, but underscores the need to integrate credit factors into housing-market analysis.

Fifth. Geographic and institutional disparity is pervasive: capital and major cities exhibit heightened sensitivity to macroeconomic shocks compared with smaller or more supply-elastic regions. Local policies, demographic trends and investor behavior further contribute to this disparity, suggesting that universal policy recommendations are insufficient. Monetary and macroprudential policies have heterogeneous effects: supply-side measures that expand the housing stock are more effective in stabilizing prices than demand-side measures, which can

worsen affordability. Coordinated policy approaches that take regional characteristics and behavioral factors into account are essential for mitigating instability and maintaining stability in housing markets.

Sixth. The studies reviewed on the price characteristics of the Bulgarian housing market, published in indexed scientific periodicals, are distinguished by good historical dynamics, coverage of macroeconomic determinants, risk structure and the social consequences of the housing market in Bulgaria. The methodological evolution is real and moving in the right direction. Nevertheless, we identify an open field for research in which studies could be conducted at the micro-level of price formation, including the attributive characteristics of the dwelling and the effects of spatial diffusion of revalorization impulses. The most promising combined research task for future studies is the development of an attributive model with spatial components and included energy-efficiency data. Such an approach would simultaneously fill three of the identified methodological gaps, correspond to European regulatory priorities, and offer directly applicable results for appraisers, investors and public authorities. Its implementation would position Bulgaria within the territory of a broader regional research discourse on the housing markets of the new Eurozone member states.

Seventh. Despite progress in econometric modeling and the expansion of research data arrays, gaps remain in fully capturing non-linearities, integrating behavioral expectations, and overcoming information constraints across different regions and data frequencies. Future research should focus on developing models that synthesize credit dynamics, supply constraints, and demand mismatches into a unified framework, while simultaneously exploring the growing role of policy coordination and financial innovation in shaping housing price cycles. The literature as a whole emphasizes that housing market dynamics reflect a multifaceted interdependence of monetary factors, supply-demand interactions, and macroeconomic conditions, requiring in-depth analysis and differentiated policy responses.

Eighth. The critical review of the scientific periodicals reveals a well-defined intellectual trajectory in research on housing prices in Bulgaria, following the rhythm of market transformations. Academic interest passes through three distinct phases: pioneering structural questions during the period of European integration (Rizov, 2003; Yotov, 2008), diagnosis of the housing price bubble and its bursting during the crisis period (Mavrov, 2011), and methodological progress after 2020 – from correlation analyses and index comparisons to formalized econometric models of increasing precision (Iliychevski et al., 2022; Zahariev et al., 2026c). The systematization of the contributions in nine key studies (see Table 1 in the dissertation) establishes relatively good thematic coverage in the area of housing-price determinants, the quantitative measurement of market risk, the social dimension of affordability, and the comparative European perspective.

CHAPTER TWO. STUDY OF THE FACTORS FOR HOUSING REVALORIZATION IN BULGARIA

The balance of the housing stock is a key indicator of the dynamics in the number of dwellings in Bulgaria from the standpoint of their qualitative and quantitative characteristics. According to the NSI methodology, its accounting includes six types of residential buildings (houses, cooperative-type residential buildings, mixed-type buildings, dormitories, villas and buildings for collective households (NSI, 2026)). The analytical presentation of the housing stock by number of rooms per dwelling (see Fig. 3) makes it possible to establish the effect of the pandemic on households' preferences for investing in dwellings with at least one additional room, to serve as a remote workspace (Zahariev et al., 2023).

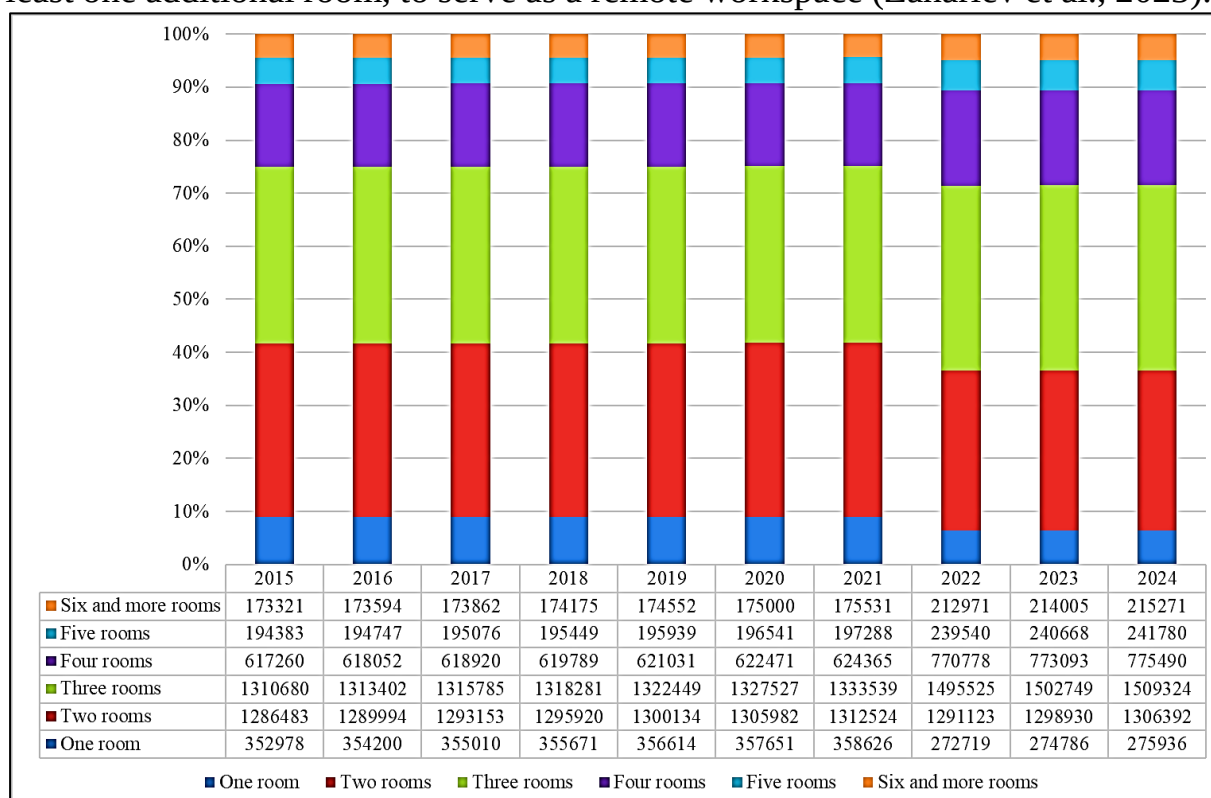


Figure 3. Balance of the housing stock in Bulgaria 2015-2024

Source: NSI, 2026 (Note: the data obtained from the census as of 7.09.2021, adjusted by adding the residential buildings and dwellings put into operation and subtracting those demolished by 31.12.2022.)

On this basis, the following more important substantive points and results are derived within the presentation of Chapter Two:

First. In the 2021 census, significantly stricter criteria were applied for defining a one-room dwelling as self-contained. As a result of these more stringent criteria, a considerable portion of the units previously reported as one-room dwellings – studios, attic apartments and garsonieres – has been reclassified or excluded from the register. In counterpoint to this methodological factor, the trend is oriented towards more spacious and investment-attractive dwellings. The relative decline of two-room dwellings in the total housing stock by 2.5 percent

over the period 2022-2024 is a consequence of a redistribution in the structure of the housing stock, where the growing shares of larger categories push down the relative weight of two-room dwellings. The trend shows that new construction has prioritized more spacious architectural solutions at the expense of smaller dwellings in the medium-sized-area category. The three-room apartment is emerging as the dominant category in new construction in 2022-2024, reflecting consumer demand for family households with an average of two or three members, for whom the area of 60–80 sq m represents an optimal balance between comfort and affordability.

Second. The analysis of the balance of the housing stock for the period 2015–2024 documents an increase of 389,088 housing units, or a rise of 9.9% compared to the base year 2015. This dynamic, however, is distributed highly unevenly between the two observed sub-periods. In the period 2015–2021 (over six years), whereas between 2021 and 2024 a qualitative jump of 322,320 units (8.1%) is recorded. A significant part of this acceleration, however, does not reflect actual construction activity but represents a methodological break caused by the transition to the registers of the NSI's 2021 Census, within which 4,261,454 dwellings were counted – 374,305 more than the 2011 data. At the structural level, the dominant dwelling categories – two-room and three-room – consistently form around two-thirds of the housing stock for the entire period under review. Three-room dwellings reinforce their leading position: their share grows from 33.31% (2015) to 34.90% (2024), and their absolute number reaches 1,509,324 units. In contrast, the share of one-room dwellings drops sharply from 8.97% (2015) to 6.38% (2024), a phenomenon the NSI explains by the stricter criteria for a self-contained dwelling applied in the 2021 Census, as a result of which a significant number of studios, attic apartments and garsonieres have been reclassified or excluded from the register. Four-room dwellings show a U-shaped trend: after a gradual decline until 2021, their share reaches 17.94% with 775,490 units in 2024. This transformation of structural shares expresses intensified consumer demand for more spacious dwellings, spurred by the growth of household disposable income and affordable mortgage financing during the period under review. The analysis reveals three analytically significant phenomena: structural inertia in the period 2015–2021 (the maximum deviation by category is under 0.1 percent); a market trend towards more spacious dwellings, reflecting actual new construction; and a methodological break after 2021, due to a revision of the registers based on NSI data. The country has over 4.3 million homes for about 6.5 million people, or almost one home per 1.5 inhabitants, which is an indicator of real security, but includes a significant uninhabited stock of cottages, hereditary properties, and homes in depopulated regions.

Third. The comparative analysis of the dynamics of the House Price Index (HPI) for the EU-27 countries for the period 2015–2024 finds that Bulgaria ranks among the countries with the highest rate of house-price growth, achieving a rise 2.2 times higher than the EU-27 average. Eurostat data (Eurostat, 2026b) show

an average HPI increase in the EU-27 of 53.44% over the ten-year period, while Hungary leads the ranking with a rise of 209.86%, followed by Lithuania, Portugal, Czechia, Bulgaria, Estonia and Poland in the first quartile. At the other extreme, Finland recorded a rise of only 1.35% over the same period. The structure of housing ownership in the EU-27 highlights the national specifics of the individual markets: 68.4% of Europeans live in owner-occupied dwellings versus 31.6% in rented ones. In this structure, Romania leads in the share of unmortgaged property with 94.3%, followed by Slovakia, Hungary, Croatia, Lithuania, Poland and Bulgaria. Germany is the only Member State with a share of owners below 50% (European Parliament, 2025). This heterogeneity of housing patterns across Member States makes universal explanations unsuitable for individual markets.

Fourth. Bulgaria's accession to the Schengen area at the beginning of 2025 and to the eurozone from 1 January 2026 forms a specific institutional backdrop that reinforces international investment interest in the market. The choice of 2015 as the base year is methodologically justified. The year is Eurostat's official base for house price indices, complies with the requirements of the European System of Accounts (ESA, 2010), and represents a relatively neutral reference point after the prolonged recovery from the global financial crisis of 2008–2009 (Brown, 2023). The acceleration of house-price appreciation in Bulgaria is symmetrical with the growth of GDP per capita – 2.48 times higher in 2024 compared to 2015 (Eurostat, 2025a) – achieved while consistently observing the Maastricht criteria.

Fifth. The alpha-beta comparative approach is a methodological approach with a field of application in: (1) normalized indices with a common base; (2) a large number of predictors, as in an array of 54 predictors, where the parallel assessment provides rich comparative information; (3) practical applicability, because the beta model is a valuable forecasting tool for investors and analysts, while the alpha model has the classical application of the single-regression equation. This approach elegantly resolves a classic econometric problem – how to present results simultaneously for a scientific audience and for practitioners, without sacrificing either precision or clarity of interpretation.

Sixth. The descriptive statistics of the 12 macroeconomic predictors (ML group) for 41 quarters (2015Q4–2025Q4) reveal a clear polarization between factors with high dynamics and those with sustained inertia. The predictors TIH (total household income, $t_{41}/t_1 = 2.91$) and GDP (gross domestic product, $t_{41}/t_1 = 2.87$) register an almost threefold increase in their values relative to the base, with a coefficient of variation above 30%. AGQWS (average quarterly gross wages, $t_{41}/t_1 = 2.83$) and GDPpC (GDP per capita, $t_{41}/t_1 = 2.85$) follow close trajectories, comparable to the growth of GHPI ($t_{41}/t_1 = 2.57$). The correlation analysis establishes exceptionally strong positive relationships: AGQWS and TIH correlate with the housing price indices at $r = 0.99$, and HICP (inflation) reaches $r = 0.97$. GDP and GDPpC show $r = 0.95$, while IMP and EXP show $r = 0.90$ and $r = 0.86$, respectively. In sharp contrast, the unemployment indicators –

UNEMPL.R (unemployment rate) and UNEMPL.N (number of unemployed persons) – register strong negative correlations of -0.74 to -0.79 with the housing price indices, confirming the inverse relationship between the labor market and housing demand (Irandoost, 2019). The labor force indicators LF and EP demonstrate a negative correlation (-0.75 and -0.58), due to the demographic contraction of the working-age population, and not to a deterioration in employment. The alpha-beta comparative analysis of the single regression models confirms the methodological reliability of the established dependencies: for TIH, AGQWS, GDP and GDPpC the difference between the model with alpha ($Y = \alpha + \beta_1 X$) and without alpha ($Y = \beta_2 X$) is minimal – ΔR^2 below 0.04. The exceptions are UNEMPL.R and UNEMPL.N, for which ΔR^2 reaches 0.15–0.20, a categorical argument that for these predictors the model with alpha is statistically significantly more reliable (Adams & Füss, 2010; Égert & Mihaljek, 2007).

Seventh. The analysis of the 8 predictors from the HHS (Household Services) group confirms the leading role of the construction cost block in shaping the price dynamics of the housing market in Bulgaria. The Index of Construction Employment Labor Costs (ICEL) achieved the highest relative growth among all predictors in the group ($t_{41}/t_1 = 3.01$) with $CV = 35.27\%$, reflecting accelerated growth in labor remuneration in the construction sector, especially under conditions of labor shortage after 2020. The Index of Construction Costs (ICE, $t_{41}/t_1 = 2.76$, $CV = 40.30\%$) and the Index of Producer Prices of Construction Materials (IPPCM, $t_{41}/t_1 = 2.68$, $CV = 42.98\%$) register comparable growth with exceptional volatility – an indicator of inflationary pressure on the construction sector after 2021. The correlation relationships within the group are exceptionally strong: ICEL correlates with the three housing price indices at $r = 0.99$, OSRAD (housing acquisition services) at $r = 0.99$ – 1.00 , and OD (housing ownership) at $r = 0.99$. A structural exception is ICD (housing-related insurance, $t_{41}/t_1 = 0.99$, $CV = 2.31\%$), whose index is practically constant throughout the period and shows a negative correlation with the other predictors (r from -0.29 to -0.65). This inverse relationship is theoretically explicable: insurance costs increase under heightened risk and uncertainty, while housing prices accelerate during periods of market stability (Doling & Ronald, 2010). The alpha-beta comparative analysis finds that for OSRAD, ICEL and IPPCM the differences between the two models are minimal (ΔR^2 below 0.01), while OD and OSROD show the largest deviation within the group, supporting the need to include an alpha component when modeling them (DiPasquale & Wheaton, 1992; Mayer & Somerville, 2000).

Eighth. The market analysis of global trends in steel production and demand for the period 2010–2025 reveals structural patterns with direct consequences for the cost of housing construction in Bulgaria and the EU-27. Data from the World Steel Association (Worldsteel Association, via Statista, 2026) document an increase in global production from 1,435 million metric tons (2010) to an absolute record of 1,963 million tons (2021), an increase of about 29% over fifteen years is recorded, but the 2025 levels (index 128.92) are

comparable to those of late 2018–2019 – an indicator of structural rather than cyclical stagnation. Analysis of the chain changes confirms increasing production volatility alongside a declining long-term growth rate. Three consecutive declines in the annual rate of change (2022/21, 2024/23 and 2025/24) find no parallel in any previous period within the horizon under review. The structure of demand is highly asymmetric: Asia and Oceania concentrate 70% of global demand for finished steel products, while Europe holds 11%. European demand shows a reverse trend relative to the Asian one – after a decline to 179.1 million tons (2024) it rises to 191.7 million tons (2025), with a projected peak of 200.3 million tons by 2027 (Worldsteel, via Statista, 2026). The trend of stabilizing or contracting global production, combined with rising European demand, generates sustained price pressure on raw materials in the construction sector, representing an objective exogenous factor for the rise in the cost of new housing construction in Bulgaria and the EU (Beer & Riedl, 2012; Anelli & Tajani, 2023).

Ninth. The analysis of the 16 predictors from the ECS (Energy and Communal Services) group reveals strong heterogeneity in the dynamics of the individual components, reflecting varying degrees of regulation and market exposure. A structural exception and analytically dominant phenomenon within the group is the behavior of the gaseous fuels index (G), which reached a peak value of about 450 index points (2022Q3) – immediately after the outbreak of the war in Ukraine – with a coefficient of variation of 47.53%, the absolute highest in the group. This extreme volatility lowers the correlation of G with the housing price indices to a moderate level ($r = 0.47$), disrupting the otherwise characteristic strong linear relationships within the group and necessitating a special econometric approach (Brolinson et al., 2026; Cermáková & Hromada, 2022). The remaining predictors in the group show high positive correlation with GHPI, HPIND and HPIED. Leading are OSRD ($r = 1.00$), ARH – actual rents ($r = 0.99$), WSMSRD ($r = 0.99$), WS – water supply ($r = 0.98$) and E – electricity ($r = 0.99$). These results confirm that regulated utility services follow a synchronized trajectory with house-price appreciation. The alpha-beta comparative analysis finds that for the regulated indicators (ARH, OSRD, WSMSRD) $\Delta\beta$ is in the range 0.25–0.40 with ΔR^2 below 0.03, while for E (electricity) alpha absorbs the base level without a substantial change in the explanatory power of the model. The potential two-way causal relationship for ARH is also highlighted: rising rent levels stimulate the acquisition of owned housing, while rising prices in turn increase market rents (Gallin, 2008; Arnott, 1987). It is noted that the more recent price wave of 2026, triggered by the crisis in the Persian Gulf and the blockade of the Strait of Hormuz, is an additional signal of a new iteration of price pressure in construction materials.

Tenth. The analysis of the 8 predictors from the Const group (Construction) establishes a seemingly paradoxical relationship: despite the significant growth in construction supply, it is in close positive correlation with the housing price indices, rather than the expected inverse one. The index of two-

room dwellings put into operation (NBDC2Rs) registers the absolute highest growth in the group ($t_{41/t1} = 6.21$) with $CV = 57.61\%$, followed by three-room dwellings (NBDC3Rs, $t_{41/t1} = 5.01$) and the total number (NBDCRT, $t_{41/t1} = 5.25$, $CV = 52.85\%$). The correlation analysis confirms positive relationships with the housing price indices: NBDCRT ($r = 0.91\text{--}0.92$), NBDC3Rs and NBDC4Rs ($r = 0.90\text{--}0.91$) and NBRBC ($r = 0.89\text{--}0.90$). NBDC1R (one-room dwellings, $r = 0.65$ with GHPI) is an exception, demonstrating a segment differentiation driven by investor – rather than consumer – motivation in acquiring small apartments. The theoretical explanation of this apparent anomaly rests on two mechanisms established in the literature. First, construction is a procyclical indicator: investors build in response to rising prices rather than ahead of them, generating a technological lag between the start of construction and its completion (Topel & Rosen, 1988; Saiz, 2010). Second, in periods of dynamically rising demand, the new supply is absorbed immediately without a downward price correction. The alpha-beta comparative analysis reveals that the Const group shows the most substantial differences in ΔR^2 among all groups studied: for NBRBC ΔR^2 reaches 0.22–0.24, while for NBDCRT and NBDC2Rs it is 0.07–0.09. These values are a categorical argument for the methodological superiority of the model with an alpha component for the construction predictors. The alpha coefficients within the group (40–75 index points) are the highest of all groups studied, confirming that housing prices possess a significant base value independent of the volume of new construction (Brausewetter, Thomsen & Trunzer, 2024; Grimes & Aitken, 2006).

Eleventh. The analysis of the predictors from the Cr (Credit Conditions and Investment Alternatives) group reveals the most polarized correlation structure among all groups studied. Housing loans (DwCr) correlate with the three housing price indices at $r = 1.00$, while bank loans secured by residential property (BLSRPi and BLSRPe) reach $r = 0.99$. These results confirm the central role of credit expansion in shaping house-price appreciation: the housing loan portfolio has grown almost threefold ($t_{41/t1} = 2.99$) over the period under review, in parallel with the growth of GHPI ($t_{41/t1} = 2.57$). The mortgage interest rate (IRATEmp) and the BNB key interest rate (IRATE) demonstrate a symmetrically opposed negative correlation ($r = -0.77$ for both), confirming the classic mechanism of stimulating demand through variations in interest rates. The period of historically low interest rates 2015–2022 emerges as a key structural factor for the unfolding of the price boom, while their partial increase after 2022 is not enough to break the already formed price inertia.

Twelfth. The index of non-performing and restructured housing loans (BRHL) registers the strongest negative correlation in the group ($r = -0.88$), reflecting the fact that the improvement in banks' credit quality – BRHL falls by over 85% relative to the base ($t_{41/t1} = 0.13$, $CV = 58.64\%$) – coincides chronologically with the acceleration of house-price appreciation. The SOFIX stock index and net foreign investment in property (NFIP) show moderate

positive correlation ($r = 0.84$ and $r = 0.82$), reflecting overall activity within the business cycle and international investment interest. In sharp contrast, the USD/EUR exchange rate (ExR) shows practically zero correlation ($r = -0.18$) – a result theoretically grounded in the functioning of the currency board in Bulgaria, whereby the exchange rate does not reflect domestic monetary impulses (Bobeva, 2017; 2019). The alpha-beta comparative analysis finds a unique result for DwCr: the models $Y = \alpha + \beta_1 X$ and $Y = \beta_2 X$ are practically equivalent (ΔR^2 below 0.01) – the only such case in the entire study among the 54 predictors – confirming an exceptionally close proportional relationship between housing credit and housing prices under normalized indices (Goodhart & Hofmann, 2008; Carrington & Madsen, 2011; Ivanov, 2025).

CHAPTER THREE. EMPIRICAL STUDY OF THE REVALORIZATION OF HOUSING IN BULGARIA IN THE PERIOD 2015-2025

The revalorization of housing prices is a process that can not only be studied, but can also bring to the fore those factors that, with the greatest statistical significance, drive forward the process of wealth growth from the standpoint of the owners of the housing stock. Measuring this process requires the selection of models that correspond as closely as possible to the stationarity characteristics of the selected factors (see Table 1). As a result, trends are established and recommendations are formulated both for investors in residential property and for the institutions responsible for conducting regulatory policies.

Table 1. Final classification of the 57 time series by order of integration

Order	Series (acronyms)	Number	Validation
I(0)	None	0	
I(1)	GDP, EXP, IMP, GDPpC, AGQWS, TIH, UNEMPL.R, UNEMPL.N, LF, EP, OR, NBRBC, NBDCRT, NBDC1R, NBDC2Rs, NBDC3Rs, NBDC4Rs, NBDC5Rs, NBDC6Rs, OSROD, ICE, HWEGOF, WS, EGOF, G, SF, HE, ICD, IRATE, HICML, BRHL, NFIP, Sofix, ExR, HPINH, HPIEH	36	Appx. 5 & 6
I(2)	GHPI, HICP, OSRAD, OD, MRM, ICEL, IPPCM, ARH, MRD, MMRD, SMRD, WSMSRD, RC, SC, OSRD, E, FHERHM, DwCr, BLSRPi, BLSRPe, IRATEMp	21	Appendix 7

Source: Author's calculations.

On this basis, the following more important substantive points and results

are derived within the presentation of Chapter Three:

First. Modeling housing prices represents a methodological challenge, with a wide variety of analytical methods. These methods are traditional and advanced. Traditional methods include regression models (Yan, 2024), comparison-based approaches, production-cost models, income-capitalization models and housing investment-return models. Advanced methods include artificial neural networks (Mimis et al., 2013), spatial-analysis techniques, hedonic pricing models, fuzzy-logic methods and ARIMA-based models (Pagourtzi et al., 2003). The latter group encompasses a range of methodological techniques, allowing joint modeling of the historical price dynamics, the autocorrelation structure and the trend components, resulting in models with statistically robust predictive power. In the study, the ARIMAX model is methodologically preferred due to the small number of quarterly observations, the focus on Bulgaria, and the transition from currency board to eurozone (2025Q4), where the question facing investors is whether the revalorization of housing in Bulgaria will accelerate or whether a plateau phase and a slowdown in price growth will set in. The analysis of the short-term dynamics of price acceleration can provide an answer to this dilemma. The use of a VAR model carries the risk of exhausting the degrees of freedom in constructing the lag structure in the hypothesis of less than 50 observations (Wu, 2025), which is also valid for VECM and is an obstacle to the reliable estimation of cointegration vectors (Johansen, 1995). Through ARIMAX, the study focuses on price acceleration by transforming the data through first and second differentiation, which directly addresses the potential problem of non-stationarity, which is typical for time series with close to synchronous growth dynamics. Alternative methods with panel models are not applicable in the framework of a single country, as they require a comparative basis for cross-national comparisons. In view of the arguments presented and considerations drawn, in this chapter of the dissertation, ARIMAX modeling (Kotu & Deshpande, 2019) is selected as the main methodological toolkit, through which the dynamics of the General House Price Index (GHPI) in Bulgaria with its component sub-indices are studied, using a stepwise variable selection procedure. This procedure allows for the identification of key predictors and the determination of their relative contribution to changes in house prices in Bulgaria in a quantitative context.

Second. The flow chart for conducting the ARIMAX modeling is based on a scheme of five logically connected sequential stages, comprising: First stage. Testing the data for stationarity using three tests, applying the majority rule: if two or more of the three tests confirm stationarity of the corresponding variable, it is classified as stationary. The tests applied are the ADF test – Augmented Dickey-Fuller test (Dickey & Fuller, 1981); the PP test – the Phillips and Perron test (1988); and the KPSS test (Kwiatkowski et al., 1992), where, unlike the ADF test, the null hypothesis of stationarity is assessed against the alternative hypothesis of a unit root. The particular value of the KPSS test stems from the fact that its null hypothesis is reversed relative to that of the ADF and Phillips-

Perron tests. Here the starting assumption is stationarity, and evidence against it is sought, rather than the reverse. In this way, the KPSS test is especially suitable for distinguishing processes in which a deterministic trend, rather than a random walk, leads to an assessment of apparent non-stationarity. Its practical advantage is that it serves as an independent check: if the ADF and Phillips-Perron tests fail to reject the presence of a unit root, then through the KPSS test we simultaneously achieve rejection of stationarity, unidirectionality of the three tests, and a majority-supported conclusion of non-stationarity (Sul, Phillips & Choi, 2005). The second stage is aimed at ensuring a scientifically correct specification of the model; the dependent variable is tested for seasonality by applying the Kruskal-Wallis test (Kruskal & Wallis, 1952), which provides a comparison of the distributions among the quarterly groups. The alternative hypothesis states that at least one quarterly group differs statistically significantly from the others, indicating the presence of seasonality. The null hypothesis is rejected if the p -value < 0.05 , in which case seasonal adjustment or inclusion of seasonal dummy variables in the model specification is considered; The third stage leads to the final specification of the model by stepwise elimination of variables based on their statistical significance and the diagnostic tests conducted at each stage of the selection procedure; The fourth stage involves assessing the fit of the model, estimating the model parameters and subjecting the model to financial and economic analysis; The fifth stage is aimed at conducting diagnostic tests for autocorrelation in the residuals, normal distribution of the residuals, ARCH effect and robustness.

Third. The ARIMAX(0,2,1)(0,0,0) model for GHPI demonstrates high explanatory power for the acceleration of house-price formation in Bulgaria: the stationary R^2 of 0.727 confirms that the three predictors explain 72.7% of the variation in $\Delta^2\text{GHPI}$. This result is comparable to the values established by Ciocchetta, Guglielminetti and Mistretta (2024) for European housing markets (60–85%). The precision indicators are within optimal ranges: MAPE = 1.026%, RMSE = 1.962 and normalized BIC = 1.724, providing a balance between explanatory power and parameter parsimony. The Ljung–Box test ($Q(18) = 16.382$; $p = 0.497$) confirms that the residuals are „white noise“ – no autocorrelation structure is found even in the periods of the pandemic shock (2020–2021) and the energy crisis (2022). Further confirmation comes from the test for ARCH effects ($LM = 15.147 < \chi^2(12) = 21.03$; $p = 0.235$), a zero count of outliers, and normality of the residuals according to Shapiro–Wilk ($W = 0.954$; $p = 0.114$).

Fourth. The three predictors identified in the ARIMAX(0,2,1) model for GHPI reflect different structural mechanisms of house-price formation in Bulgaria. The leading price-forming factor is WSMSRD ($\beta = 0.385$; $p < 0.001$) – a synthetic index of utility-infrastructure costs, whose capitalization into prices acts procyclically and directs demand towards more efficient dwellings. Household income TIH ($\beta = 0.011$; $p = 0.002$) confirms the classic relationship

between effective demand and price acceleration under constrained supply, documented in a number of European studies (Duca et al., 2021; Goodhart & Hofmann, 2008). The construction labor-cost index ICEL ($\beta = -0.098$; $p < 0.001$) has a cooling effect through the dual mechanism of reduced investment attractiveness and slowed new construction, consistent with the theory of the price elasticity of supply (Caldera Sánchez & Johansson, 2011).

Fifth. The stability check through five alternative ARIMA specifications confirms that the coefficients of the three exogenous predictors are structurally stable – WSMSRD varies only within the range of significance across the entire range of tested models. It is critically important that the inclusion of GDP (GDP_D2) as a fourth predictor significantly worsens all characteristics: the stationary R^2 falls by 21.3%, RMSE increases by 27.1%, and the Normalized BIC exceeds the threshold of a substantial difference ($\Delta BIC = 0.574 > 0.5$), while GDP_D2 itself is statistically insignificant. This is fully consistent with the thesis of Baffoe-Bonnie (1998) and Duca et al. (2021), that macroeconomic aggregates influence the housing market indirectly – through sector-specific financial and cost channels rather than directly – and confirms that ARIMAX(0,2,1)(0,0,0) is the correctly identified, minimally parsimonious specification for analyzing the price acceleration of the housing market in Bulgaria. 0.385–0.390, TIH остава при 0.011, а ICEL запазва отрицателния знак и статистическата

Sixth. The ARIMAX(1,2,0)(0,0,0) model for HPIED identifies four statistically significant predictors. The stationary $R^2 = 0.735$ means that 73.5% of the variation in the acceleration/deceleration of price growth ($\Delta^2 HPIED$) is explained by the four selected predictors. This explanatory power is comparable to European housing markets (Ciocchetta, Guglielminetti & Mistretta, 2024). The strongest factor is ICEL ($\beta = -0.188$; $p < 0.001$) – the most powerful factor. For a 1-unit acceleration in construction labor costs, the price acceleration of HPIED decreases by 0.188 units in the same quarter. The effect is particularly pronounced for existing dwellings due to the high share of manual labor in renovation and restoration activities (Caldera Sanchez & Johansson, 2011; Aydinli, 2024). TIH ($\beta = +0.019$; Lag 1; $p < 0.001$) acts with a one-quarter lag – the acceleration in income translates into effective demand the following quarter (Duca, Muellbauer & Murphy, 2021). NBRBC ($\beta = +0.007$; $p = 0.022$) signals growing market demand, while SOFIX ($\beta = -0.022$; $p = 0.021$) plays the role of an alternative investment channel, suppressing house-price acceleration (Case, Quigley & Shiller, 2005). The autoregressive component AR(1) with $\phi_1 = -0.443$ ($p = 0.023$) reveals a mechanism of partial market correction: accelerated price increases in one quarter are followed by a slower pace in the next. This inertial characteristic is inherent to markets with transaction costs, information asymmetry and limited liquidity (Egert & Mihaljek, 2007; Gattini & Hiebert, 2010).

Seventh. The set of diagnostic tests categorically confirms the adequacy of the ARIMAX(1,2,0) specification. The four criteria are satisfied simultaneously across 41 observations, covering periods with multiple structural disturbances.

Autocorrelation: Ljung-Box $Q(18) = 10.957$ at $p = 0.859$ – the highest p -value among all five tested specifications. All 16 ACF coefficients are insignificant (none exceeds $\pm 2SE$). Normality: Shapiro-Wilk $W = 0.976$ ($p = 0.565$), K-S $D = 0.106$ ($p = 0.200$). Skewness = 0.043, kurtosis = -0.177 – insignificant deviations from the normal distribution. Homoscedasticity: $LM = 7.462 < \chi^2(12) = 21.03$, $F(12,13) = 0.436$ ($p = 0.920$), $DW = 1.823$. Zero outliers. These results show that the model successfully absorbs the structural shocks of the pandemic (2020-2021) and the energy crisis (2022) without leaving a trace in the residual errors (Engle, 1982; Kotu & Deshpande, 2019; Tukey, 1977).

Eighth. The stability check through five alternative ARIMA specifications confirms the structural stability of the estimates. The stationary R^2 varies only between 0.734 and 0.748, and RMSE – between 2.314-2.353. ARIMAX(1,2,0) achieves the lowest Normalized BIC = 2.253 with the highest Ljung-Box $p = 0.865$. ICEL_D2 retains a negative sign and $p < 0.001$ across the whole range (-0.149 to -0.197); NBRBC_D2 is consistently positive and significant (0.006-0.008; $p < 0.05$); SOFIX_D2 retains a negative effect in all specifications. The difference in BIC between ARIMAX(1,2,2) and ARIMAX(1,2,0) = 0.206 is below the threshold of 2 units (Kass & Raftery, 1995), but the principle of parsimony points to ARIMAX(1,2,0). The price dynamics of HPID are determined primarily by labor costs and housing affordability – not by macroeconomic aggregates such as GDP. This is consistent with Baffoe-Bonnie (1998), Duca, Muellbauer & Murphy (2021), and provides practical relevance for housing-affordability and construction-activity policies in Bulgaria (Idrizov, 2025; Iliev, 2024; Stoenchev & Hrischeva, 2025).

Ninth. The ARIMAX(1,1,0) model for the price index of new dwellings (HPIND) is built on logarithmized series, integrated of order one $I(1)$, so that after a single differencing the coefficients are interpreted as elasticities. They show by what percentage the growth rate of HPIND changes for a 1% change in the growth rate of the corresponding predictor. The model identifies four exogenous determinants and an autoregressive component, jointly covering market correction, alternative investment, cost pressure, income-supported demand and the investment-consumption incentives from the rental housing market. The autoregressive component $AR(1)$ with coefficient $\phi_1 = -0.404$ reveals a mechanism of partial market correction: accelerated price growth in one quarter is regularly followed by a slowdown in the next, which is a characteristic of markets with information lags and transaction costs.

Tenth. Among the exogenous predictors, the leading role is played by actual housing rents (Lg_ARH, $\beta = +0.528$), which is the strongest factor in the model. The increase in rents accelerates housing prices simultaneously through two channels: investment (buying a home becomes more attractive than renting) and consumer (renters increase their appetite for acquiring their own home). The second strongest is the total quarterly gross household income (Lg_TIH, $\beta = +0.437$), the effect of which is immediate with lag 0, reflecting without delay the

immediate conversion of the faster growing purchasing power into increased demand for housing. The third strongest predictor is water utility prices (Lg_WS, $\beta = +0.207$ at Lag 1): the cost pressure from rising utility tariffs is passed on to housing prices with a three-month lag, reflecting the time it takes for builders and landlords to capitalize on higher operating costs. The main BSE index (Lg_SOFIX, $\beta = +0.086$) operates in the same quarter, but has the weakest effect. It functions more as an indicator of investor confidence than as a direct price driver.

Eleventh. The ARIMAX(1,1,0)(0,0,0) model for the price index of new dwellings in Bulgaria (HPIND) demonstrates high diagnostic adequacy, confirmed simultaneously across all standard econometric criteria. The stationary $R^2 = 0.418$ shows that the four exogenous predictors explain 41.8% of the variation in the growth rate of new-dwelling prices – a result consistent with the specifics of a logarithmized I(1) model, in which the coefficients are interpreted as elasticities of growth rates. The Ljung–Box test registers $Q(18) = 14.525$ at $p = 0.630$, categorically confirming that the residuals represent „white noise“ without a systematic autocorrelation structure, while normality is verified through exceptionally strong results from Shapiro–Wilk ($W = 0.994$; $p = 0.998$) and Kolmogorov–Smirnov ($D = 0.065$; $p = 0.200$) – values that rank the HPIND model first in normality among the three models analyzed. Homoscedasticity of the conditional variance is confirmed through $LM = 8.937 < \chi_{0.005}(12) = 21.03$, $F(12, 14) = 0.578$ at $p = 0.826$ and Durbin-Watson = 2.074, ruling out the need for a GARCH extension. The stability check through five alternative ARIMA specifications confirms the structural stability of the model: Normalized BIC varies within the narrow range of -7.459 to -7.263 , the coefficients of Lg_ARH_D1 (0.490–0.568), Lg_TIH_D1 (0.420–0.438) and Lg_SOFIX_D1 retain their signs and significance across the whole range, and ARIMAX(1,1,0) achieves the lowest BIC at the highest Ljung–Box p-value among all configurations tested. The overall set of results confirms that ARIMAX(1,1,0)(0,0,0) is the correctly identified, economically justified and statistically adequate specification, successfully capturing the three price-formation mechanisms for new dwellings in Bulgaria – rental-investment arbitrage (ARH), income-driven demand (TIH), and cost-side supply (WS) – supplemented by the market-sentiment signal (SOFIX) and the inertial autoregressive correction (Meen, 2002; Case, Quigley & Shiller, 2005; Idirizov, 2025).

CONCLUSION

The dissertation research conducted on the revalorization of housing in Bulgaria makes it possible **to confirm the main thesis** that, in the process of the country's cohesion and catching-up economic growth, Bulgaria, as an EU member

state, achieves a revalorization of housing, as measured through the general house price index and its constituent sub-indices, which is due to the influence of factors unique to the country, reinforced by the accelerating effect of the country's accession to the Eurozone.

The dissertation achieves an enrichment of scientific knowledge and validation of the working hypotheses by revealing in depth the processes and determinants affecting a key component of wealth in Bulgaria – housing prices and their revalorization trajectories, based on data for the period 2015Q4-2025Q4. More specifically, the scientific results achieved, together with the supporting theoretical and empirical-applied evidence, are formulated as follows:

1) An original multi-criteria analytical framework has been developed for the critical synthesis of the academic literature on the factors of housing-price formation, combining five thematically focused groups for assessing the studies: sensitivity to interest-rate levels, elasticity of demand and supply, credit conditions and mortgage markets, regional disparity, and the effectiveness of market-regulation policies. The framework has been applied to a representative sample of indexed studies, enabling systematic identification of the degrees of consistency and contradiction in the scientific periodicals. The results reveal that consensus is highest regarding the inverse relationship between interest-rate levels and housing prices and the leading role of supply elasticity in mitigating price instability, while the relative weight of demand versus supply, the intensity of the credit channel, and the effectiveness of macroprudential policies remain the subject of active debate with heterogeneous empirical evidence. Ten specific, prioritized research directions are systematized, including regional disparity in interest-rate sensitivity, non-linear and asymmetric market reactions, integrated modeling of credit conditions, behavioral factors and expectations, supply-side data, interaction between macroeconomic shocks and local markets, coordination of monetary and macroprudential policies, time-variability of determinants, international differences in mortgage markets, and integration of behavioral and macro-financial interdependencies.

2) An original five-period chronological periodization of the academic analysis of house prices from 1990 to the present is proposed, outlining a specific thematic and methodological profile of each period: foundational macroeconomic models (1990–1999); integration of monetary policy and credit effects, culminating in the diagnosis of the mortgage crisis (2000–2009); extended international comparative analyses with panel data (2010–2014); financialization and behavioral aspects (2015–2019); and macroprudential policies and regional unevenness in conditions of multiple crises (2020 to the present). In parallel, an author's systematization of scientific contributions to the housing market in Bulgaria was developed and verified, covering twelve indexed studies for the period 2003–2026. The systematization documents the trajectory from qualitative market analyses and descriptive statistics to formalized econometric models and risk metrics from financial theory, identifies three unfilled methodological niches

- attribute pricing, spatial econometrics and algorithmic approaches, as well as four thematic gaps with increasing practical relevance: the effects of digital platforms, the price premium from the energy class, the systematic study of foreign demand after 2020 and the empirical consequences of membership in the Eurozone.

3) An original theoretical framework has been developed and verified, which positions housing simultaneously within the five-component systematization of national wealth by elements and within its three-layer structure by economic agents, integrating the perspectives of financial-economic theory, public law and macroeconomic modeling. Within the proposed extended tripartite model of household wealth, housing is analyzed in its threefold role: as a consumer good, as an investment asset, and as loan collateral – three functions with different implications for price formation, the monetary-policy transmission mechanism, and financial stability. On this basis, the research hypothesis is substantiated that the price dynamics of housing cannot be adequately explained through isolated supply-and-demand models, but require an analytical framework that simultaneously accounts for macroeconomic determinants, credit conditions, the institutional context, and the factors specific to small open economies – such as the currency-board system in Bulgaria, transformed into full Eurozone membership as of 1 January 2026. The framework integrates the channels of influence established in the literature – interest-rate, credit, wealth and expectations-based – into a unified conceptual scheme with direct application to the construction of multifactor econometric models.

4) An original methodological approach has been developed and verified for the simultaneous parametric assessment of two alternative single regression models – the first with an intercept ($Y = \alpha + \beta_1 X$), while the second has no intercept ($Y = \beta_2 X$). The two models are applied in parallel to three dependent variables (GHPI, HPIND and HPIED) and 54 predictors in five thematic groups over a period of 41 quarters (2015Q4–2025Q4). The approach enables the simultaneous performance of three analytical tasks: assessing the statistical significance and economic interpretation of the alpha parameter, establishing the stability of the beta coefficient under the alternative specification, and quantitatively measuring the differences in explanatory power (ΔR^2) as a criterion for selecting the more adequate model. The methodological value of the approach is demonstrated through its systematic application, whereby qualitatively different behavior patterns are identified across different predictor groups – from practical equivalence of the two models (for DwCr, $\Delta R^2 < 0.01$) to substantial methodological superiority of the alpha model (for BRHL and NBRBC, $\Delta R^2 > 0.19$), which makes the approach a valuable tool for both academic audiences and practitioners.

5) For the first time in the Bulgarian scientific literature, a comprehensive regression-correlation framework has been built and verified, systematizing 54 predictors into five thematic groups: macroeconomics and the labor market;

housing acquisition and construction services; energy-supply and utility costs; new-construction supply; and credit conditions and investment alternatives. On this basis, the empirical hierarchy of their influence on the three measures of the house price index in Bulgaria has been established. The results reveal that the leading determinants are factors related to household income, housing credit, and construction-sector labor costs, which show correlation indicators close to unity. Predictors with low variability (such as the BGN/USD exchange rate (resp. USD/EUR), net foreign investment in real estate, and housing-related insurance) demonstrate statistically insignificant influence regardless of their theoretical justification. The procyclical nature of construction supply in Bulgaria has also been established. The growth in dwellings put into operation moves in parallel with, rather than inversely to, price growth, which is empirical evidence of a structural supply deficit relative to demand during the period studied.

6) On the basis of a comparative analysis of the House Price Index (HPI) for all 27 EU member states for the period 2015–2024, it has been established and analytically substantiated that the growth in housing prices in Bulgaria is 2.2 times higher than the EU27 average, with the average annual growth rate being 1.82 times higher than the European average. The specific institutional factors underlying this accelerated revalorization have been identified: the currency-board regime with a fixed exchange rate to the euro, generating a substitution effect between mortgage installments and rents; the significant share of panel buildings in the housing stock as an object of public and private investment; and the ex ante revalorization premium formed by the prospect of eurozone accession from 1 January 2026. These factors act as independent price amplifiers, distinct from macroeconomic determinants, and explain why price dynamics in Bulgaria cannot be adequately interpreted through universal models developed for countries with a different level and dynamics of economic development.

7) An original five-step methodological procedure for ARIMAX modeling has been developed and applied, specifically adapted for studying the change and acceleration of housing revalorization with small samples of quarterly data. The procedure integrates: (1) triple stationarity testing through ADF, PP and KPSS tests with a majority rule – two out of three tests for classifying the order of integration; (2) the non-parametric Kruskal–Wallis test for seasonality, suitable for small samples without a normality assumption; (3) an iterative, staged predictor-selection procedure from an array of 54 candidate variables; (4) parameter estimation and financial-economic interpretation; and (5) a complete set of diagnostic tests – Ljung–Box for autocorrelation, Shapiro–Wilk and Kolmogorov–Smirnov for normality of the residuals, and Engle's LM test for ARCH effects. Application of the procedure to 57 time series (three dependent variables and 54 predictors) for the period 2015Q4–2025Q4 establishes that none of the series is stationary at levels $I(0)$, 36 are $I(1)$, and 21 – including the dependent variable GHPI – are integrated of the second order $I(2)$, which requires a specification with double differencing and orients the study not towards the

levels or rates of change, but towards their acceleration for GHPI & HPIED. The methodological advantage of choosing ARIMAX over VECM and VAR is substantiated by the limited number of observations ($n = 41$), the risk of exhausting the degrees of freedom when constructing the lag structure, and the distinction of short-term price acceleration as an independent research focus.

8) 8) For the first time in the Bulgarian scientific literature, three independent ARIMAX models have been constructed and verified for the three dimensions of the housing price index – GHPI, HPIED and HPIND – each with a separate specification, justified by the order of integration of the included series, and verified through a full set of diagnostic tests. The ARIMAX(0.2.1) model for GHPI identifies three key determinants: utility costs (WSMSRD, $\beta = +0.385$), household income (TIH, $\beta = +0.011$) and construction labor costs (ICEL, $\beta = -0.098$), with stationary $R^2 = 0.727$, MAPE = 1.026% and Ljung–Box $Q(18) = 16.382$ ($p = 0.497$). The ARIMAX(1,2,0) model for HPIED includes four predictors – household income TIH ($\beta = +0.019$, Lag 1), construction labor costs ICEL ($\beta = -0.188$), number of newly constructed residential buildings NBRBC ($\beta = +0.007$) and SOFIX ($\beta = -0.022$) – with stationary $R^2 = 0.735$ and Ljung–Box $Q(18) = 10.957$ ($p = 0.859$). The ARIMAX(1,1,0) model for HPIND, estimated on log-weighted series with I(1) stationarity, reveals four predictors – actual housing rental costs ARH ($\beta = +0.528$), household income TIH ($\beta = +0.437$), water service prices WS ($\beta = +0.207$, Lag 1) and SOFIX ($\beta = +0.086$) – with stationary $R^2 = 0.418$ and Ljung–Box $Q(18) = 14.525$ ($p = 0.630$). Diagnostic tests categorically confirm the adequacy of all three models: the residuals are "white noise" (zero autocorrelation), normally distributed (Shapiro–Wilk $p > 0.10$ in all three) and without ARCH effects (LM statistics below the critical $\chi^2_{0.05}(12) = 21.03$), and the number of identified outliers is zero in all three models.

9) Through the stability check of the three ARIMAX models, it has been established and empirically verified that traditional macroeconomic (aggregates) predictor selection from an array of 54 candidate variables for the period under review. The inclusion of GDP (GDP_D2) as an additional predictor in the GHPI model worsens the stationary R^2 by 21.3% (from 0.727 to 0.572), increases RMSE by 27.1%, and raises the normalized BIC by 0.574 units above the significance threshold, confirming that the general macroeconomic aggregates act indirectly – through sector-specific financial and cost channels. The determinants established reveal three structural price-formation mechanisms: a household-cost channel through utility tariffs and construction/renovation labor costs; an income channel through the growth of gross household income; and an arbitrage channel between rental levels for letting/renting dwellings and returns from alternative capital-market investments. The segment-specific determinants distinguish the market for new and existing dwellings: for HPIED the leading factor is the labor-cost factor (ICEL, $\beta = -0.188$, the largest coefficient by absolute value among all three models), while for HPIND rental-investment arbitrage dominates (ARH, $\beta = +0.528$). The autoregressive component $MA(1) = 0.650$ for GHPI and $AR(1) =$

–0.443 for HPIED reveal structurally different inertial dynamics: for the general index, price shocks are transmitted pro-cyclically into the next period, whereas for existing dwellings the mechanism is an autoregressive correction, characteristic of markets with information asymmetry and limited liquidity.

In summary, the study identifies and fills a significant research gap, resulting from the lack of empirical models that systematically test which of the potential determinants of house prices retain their explanatory power under conditions of prolonged currency convergence. Filling this gap is of a scientific novelty in nature, expanding the tools and opportunities available to policymakers and central bankers for monitoring the housing market in a changing institutional environment.

4. SCIENTIFIC AND SCIENTIFIC-APPLIED CONTRIBUTIONS OF THE DISSERTATION

- 1) A critical synthesis and multi-criteria systematization of the findings in the indexed scientific periodicals on the determinants of housing prices in an international context and chronological aspect.
- 2) A chronological periodization of the methodological evolution in studies on housing prices, and an original systematization of the scientific findings on the topic by Bulgarian authors in the indexed scientific periodicals.
- 3) A theoretical framework for positioning housing within the multi-layered structure of national wealth and household wealth.
- 4) An original methodology for the parallel parametric assessment of single regression relationships through alpha-beta comparative analysis, for assessing the change in the house price indices in Bulgaria.
- 5) Empirical verification of the hierarchy of housing-price determinants in Bulgaria through a systematized multi-group regression-correlation framework.
- 6) Positioning of Bulgaria within the European context of house-price appreciation and identification of the institutional factors of accelerated housing-stock revalorization.
- 7) A verified five-step methodological procedure for ARIMAX modeling of the dynamics of housing revalorization.
- 8) Derived and empirically verified sector-specific ARIMAX models for assessing the change in the prices of new dwellings based on first-differenced data, as well as for identifying and quantifying the driving forces of the acceleration in price changes for existing dwellings and for the housing stock as a whole in Bulgaria, based on second-differenced data.
- 9) Identification of the sector-specific determinants of the acceleration of housing revalorization in Bulgaria, and empirical rejection of aggregated macroeconomic indicators as statistically significant price predictors.

5. DIRECTIONS FOR FUTURE RESEARCH

As **directions for future research** on the topic, we can develop arguments and point to research niches in ten priority directions, whose development would substantially enrich the theory and practice of housing-price formation. The first direction concerns the regional disparity in the sensitivity of housing prices to interest-rate levels – a phenomenon documented in the literature, but whose causes remain insufficiently studied, which calls for the development of region-specific models incorporating supply elasticity, credit conditions and demographic factors (Aastveit & Anundsen, 2022). The second direction relates to the non-linear and asymmetric reactions of housing markets to oppositely acting demand and supply shocks, whose quantitative measurement through non-linear econometric models would improve the precision of forecasts and policies for mitigating cyclical upswings and downswings (Gluszak & Trojanek, 2024). The third and fourth directions concern, on the one hand, the integrated modeling of credit conditions and mortgage-market disparity, and on the other, behavioral factors and speculative expectations as determinants of price instability – two areas whose fuller incorporation into econometric models would enhance the effectiveness of macroprudential policies (Ma & Zhang, 2022; Ciocchetta et al., 2024). The fifth direction concerns the limitations of supply-side data – availability of building land, planning regulations and construction costs – whose harmonization across regions is a necessary condition for understanding price surges and for designing effective policies, including in the context of fiscal competition at the municipal level and transaction costs in acquiring housing (Zahariev, 2025). The sixth direction places emphasis on the interaction between national macroeconomic shocks and local housing markets, whose study through spatial econometrics and multi-stage modeling would refine the regional design of stabilization policies. The seventh direction focuses on the effectiveness and coordination of monetary and macroprudential policies, while the eighth focuses on the time-variability of price determinants under different economic regimes, whose tracking requires models with time-varying parameters and long historical data series (Plakandaras et al., 2020). The ninth direction addresses institutional differences among countries in the regulation of mortgage markets as a key factor complicating the generalization of findings on the transmission of monetary policy to housing prices (Trojanek et al., 2023). The tenth direction – the development of integrated macro-financial-behavioral models capturing the complex feedback loops in housing markets – is identified като ключово бъдещо предизвикателство, с потенциал да информира по-ефективно макропруденциалното регулиране (Duca et al., 2021; Bekiros et al., 2020).

In addition to the above, the scientific research on the Bulgarian housing market contains methodological and thematic niches, outlined as priority directions for future research in both methodological and thematic terms:

First. From a methodological standpoint, the following research directions with high analytical potential can be applied: hedonic (attributive) pricing, which

would decompose the market price of a dwelling into the constituent values of its characteristics; spatial econometric modeling of the Spatial Lag and Spatial Error type, accounting for the geographic logic of the diffusion of price impulses among cities; and algorithmic approaches based on machine learning.

Second. From a thematic standpoint, research niches of growing practical relevance remain unfilled: the effect of digital intermediary platforms (Airbnb, Booking) on the housing and rental market in tourist-attractive centers such as Sofia, Varna, Burgas and the winter resorts; the price premium generated by the energy class of dwellings amid growing EU regulatory requirements; the systematic study of foreign demand after 2020; and the empirical effects of Eurozone membership from 1 January 2026 as a counterpoint to the pre-convergence period.

The study conducted does not, of course, exhaust the spectrum of predictors of housing revalorization in Bulgaria. It does, however, achieve depth of analysis at a key moment – the transition from the currency-board regime to Eurozone membership – which charts new horizons and lays the foundations for new scientific output.

6. REFERENCE ON THE NOMENCLATURE OF AUTHOR'S PUBLICATIONS ON THE TOPIC OF THE DISSERTATION

Indicator D6. Articles and reports published in scientific publications referenced and indexed in world-renowned scientific databases: **4 items in Scopus & Web of Science – 25.29 points.**

Indicator D7. Articles and reports published in non-referenced journals with scientific peer review or published in edited collective volumes: **22 items (incl. 10 sole-authored) – 150.33 points.**

Indicator D8. Studies published in scientific publications referenced and indexed in world-renowned scientific databases: **2 items in Scopus & Web of Science – 18.75 points.**

Indicator D9. Studies published in non-referenced journals with scientific peer review or published in edited collective volumes: **4 items (incl. 2 sole-authored) – 40.50 points.**

Total for Group D: 234.87 points

<i>D6. Articles and reports published in scientific publications referenced and indexed in world-renowned scientific databases</i>
Zahariev, A., Zveryakov, M., Prodanov, S., Zaharieva, G., Angelov, P., Zarkova, S., & Petrova, M. (2020, March). Debt management evaluation through support vector machines: on the example of Italy and Greece. <i>Entrepreneurship and Sustainability Issues</i> , 7(3), 2382-2393. DOI: https://doi.org/10.9770/jesi.2020.7.3(61) (SCOPUS & WoS)
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Laktionova, O., Dobrovolskyi, O., Karpova, T. S., & Zahariev, A. (2019). Cost Efficiency of Applying Trade Finance for Agricultural Supply Chains. <i>Management Theory and Studies for Rural Business and Infrastructure Development</i> , 41(1), 62-73. DOI: https://doi.org/10.15544/mts.2019.06 (Web of Science)
TOTAL POINTS FOR INDICATOR D6: 4 publications
<i>D7. Articles and reports published in non-referenced journals with scientific peer review or published in edited collective volumes</i>
Zahariev, A. (2026). Econometric assessment of the influence of financial and economic factors on the prices of new homes in Bulgaria (2015-2025). <i>Proceedings of International</i>

Scientific and Practical Conference "Sustainability and Economic Resilience in the Context of Global Systemic Transformations", 5th Edition, March 19-20, 2026, Chişinău, pp. 87-93, ISBN 978-9975-182-23-2 (PDF), DOI: <https://doi.org/10.53486/ser2026.08>

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TOTAL POINTS FOR INDICATOR D7: 22 publications

D8. Studies published in scientific publications referenced and indexed in world-renowned scientific databases

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TOTAL POINTS FOR INDICATOR D8: 2 publications

D9. Studies published in non-referenced journals with scientific peer review or published in edited collective volumes

Андрей Захариев (2018) Балансови позиции на БНБ в условията на членство в ЕС, Алманах научни изследвания. СА Д. А. Ценов - Свищов бр. 26/2018, стр. 17-44; СА "Д. А. Ценов"; ISSN:1312-3815

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TOTAL FOR INDICATOR D9: 4 publications

7. COMPLIANCE WITH THE REQUIREMENTS OF THE RIALDASRB FOR THE AWARD OF THE SCIENTIFIC DEGREE „DOCTOR OF SCIENCES“ IN PF 3.8 „ECONOMICS“

Number of points achieved in accordance with the Annex to Art. 1a, para. 1 of the Regulations for the Implementation of the Act on the Development of the Academic Staff in the Republic of Bulgaria, with the Minimum National Requirements for the scientific, teaching and/or artistic-creative or sporting activity of candidates for the acquisition of a scientific degree and for holding the academic positions of „Head Assistant Professor“, „Associate Professor“ and „Professor“ in scientific fields and/or professional fields in Field 3. Social, Economic and Legal Sciences, Professional Field 3.1. Sociology, Anthropology and Cultural Studies, 3.2. Psychology, 3.3. Political Science, 3.4. Social Activities, 3.5. Public Communications and Information Sciences, 3.6. Law, 3.7. Administration and Management, 3.8. Economics, 3.9. Tourism:

Group **A**, indicator 1 – **50 points** (50 points required)

Group **B**, indicator 2 – **100 points** (100 points required)

Group **D**, indicators 6, 7, 8 and 9 – **234.87 points** (100 points required)

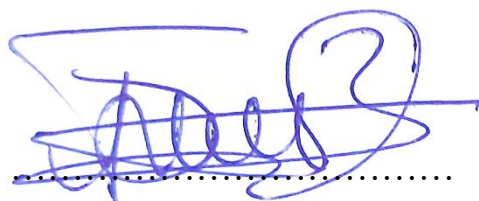
Group **E**, indicator 11 – **750 points** (100 points required)

Total: 1134.87 points

8. DECLARATION OF ORIGINALITY

The dissertation, comprising 390 pages, entitled: „**DWELLINGS REVALORIZATION IN BULGARIA: FACTORS, MODELS, TRENDS**“, for the award of the scientific degree „Doctor of Sciences“ in professional field 3.8 „Economics“, is authentic and constitutes the author's own scientific output. It employs the author's own ideas, texts and visualizations through graphs, diagrams, tables and formulas, with all requirements of the Copyright and Related Rights Act observed through the proper citation and referencing of others' authorial thought, as well as data, including:

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3. The scientific results that have been obtained, described and/or published by other authors are duly and thoroughly cited in the bibliography.



(Prof. Andrey Zahariev, PhD)

Sofia, 4 July 2026