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Reflecting the Sustainability Dimensions on the Residential Real Estate Prices

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Abstract: The paper analyzes the reaction of residential property prices to sustainability attributes and the extent to which they capitalize the effects of sustainability on real estate markets in EU-28 countries in the period 2000–2018. Given that the sustainable real estate market is mainly driven by demand, the sustainability attributes included in the study reflect both buyers' expectations and their investment potential in sustainable residential properties, and developers' efforts to become more "sustainable" through responsible property investment. In order to correspond to the current meaning of sustainable development, the variables capture the four dimensions that give content to the concept of the quadruple bottom line: economic, social, environmental and institutional. Using panel data and the two-stage least squares (2SLS) method, the research reveals a pronounced sensitivity of residential property prices to all sustainability dimensions in countries considered leaders in implementing the Sustainable Development Goals (SDGs), characterized by a strong institutional environment, and efficient and transparent real estate markets. In countries less committed to SGD implementation, weak governance and higher corruption negatively affect the transparency of real estate markets, and the dynamics of the price of residential transactions are determined only by the economic and social dimensions of sustainability.

Keywords: housing prices; sustainable development; Sustainable Development Goals; triple bottom line; quadruple bottom line; responsible property investment

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Citation: Mironiuc, M.; Ionașcu, E.; Huian, M.C.; Țaran, A. Reflecting the Sustainability Dimensions on the Residential Real Estate Prices. *Sustainability* **2021**, *13*, 2963. https://doi.org/10.3390/su13052963

Academic Editor: Colin A. Jones

Received: 30 January 2021
Accepted: 5 March 2021
Published: 9 March 2021

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1. Introduction

The ultimate goal of sustainable development is to increase the quality of life [1]. By exerting direct influences on human health and well-being, the environment and economic development, the real estate sector accounts for more than half of global wealth and, thus, it is expected to make a decisive contribution to achieving the goal of sustainable development. A major consumer of energy, water and raw materials, and a major polluter, the real estate industry has been repeatedly criticized for its slow response and low contribution to sustainable development [2], being called upon to adapt its strategies to the challenges of economic sustainability as well as health and well-being objectives [3]. In recent years, sustainability in the real estate sector has gone from being a niche to a mass trend. This move has been accompanied by a change in the perception of the real estate industry which has begun to adopt global sustainable development policies for the benefit of developers, end users and society [3].

The literature on the interrelationships between the built environment and the dimensions of sustainability debates the extent to which the price of residential properties reflects market value, under the influence of supply and demand factors. Representative

authors [4–6] have been engaged in the analysis of sales prices and premium rents for sustainable buildings compared to standard constructions. Studies that discuss the influence of sustainability on real estate prices abound in the literature, especially with reference to the energy efficiency of green buildings [5,7] and from a microeconomic perspective [8], based on the hedonic price theory proposed by Rosen (which discusses the importance of the utility value of the characteristics of a real estate, reflected in their implicit prices on the real estate market [8]). The microeconomic approach takes into account only the location and characteristics of real estate [9], studying the particularities of local real estate markets (such as the acute housing crisis accessible to low- and middle-income urban populations, inelasticity of the supply of residential properties in relation to the demand, the rigidity of the local urban regulations, the change of the population's lifestyle through the migration from rural to urban areas or vice versa, the regulation of the rental market at the local level, etc.). The determinants of real estate transaction prices at the macroeconomic level, in order to understand the specific conditions and efficiency of markets in the world, are only studied with emphasis on the economic and social dimensions of sustainability [10,11].

Following the logic of studies based on hedonic price theory, this paper analyzes the reaction of residential property prices to sustainability attributes that illustrate not only the economic and social dimensions, but also the environmental and institutional dimensions of sustainable development (according to the quadruple bottom line (QBL) approach) from a macroeconomic perspective, using aggregate variables relative to EU-28 countries. The purpose of the study is to seek answers to the following research questions: *Do the sustainability attributes of residential properties have the ability to influence transaction prices? How are the macroeconomic dimensions of sustainability perceived in the formation of residential property prices in the European Union?*

The study uses country-level data for a period of 19 years (2000–2018), and proposes a set of indicators that are likely to have an impact on the relationship between residential real estate prices and sustainability dimensions. The analysis is based on three models: one that captures the basic pillars of sustainability through its economic and social dimensions (called the E&S model), a second one which adds attributes of the environmental dimension, according to the triple bottom line (TBL) vision (TBL model), and a third which is amplified with attributes of the institutional dimension (QBL model). The study joins the literature debate on sustainability in real estate and investigates the degree of capitalization of the attributes of the four dimensions of sustainable development within the EU-28 countries. The results show a strong connection between real estate prices and the economic and social characteristics of sustainability within EU-28 member countries, a low influence of environmental attributes and a lack of capitalization of institutional attributes in prices. The relevance of some of the environmental and institutional attributes increases for the countries highly involved in the implementation of the Sustainable Development Goals (SDGs). The robustness tests have confirmed these results.

These findings may be relevant to the parties involved in residential property transactions, mainly developers and end users, providing a better understanding of the extent to which market prices capitalize sustainability attributes with implications for meeting the demand and managing costs for sustainable housing.

The rest of the paper is organized as follows: Section 2 presents the hypotheses of the research developed in the context of the review of the literature in the field of sustainable real estate markets, in the vision of the triple bottom line (TBL) and quadruple bottom line (QBL), and of the theoretical connection between real estate prices and the dimensions of sustainability. Section 3 describes the empirical approach, providing details about the selection of variables, grouped by the economic, social, environmental and institutional dimension of sustainable development, data sources and the econometric specification. Section 4 discusses the results of the two stages of the research, and Section 5 concludes the paper.

2. Literature Review and Hypotheses Development

2.1. Real Estate Sustainability: From Triple Bottom Line to Quadruple Bottom Line

Since it first appeared in the 1970s, when the economic growth–conservation of resources equilibrium was the essence of international debates, the concept of sustainability has significantly evolved. Nowadays, the 17 global objectives associated with the 2030 Agenda for Sustainable Development tend to reach a significant level of popularity and acceptance on a global scale [12]. The evolution of the framework for understanding sustainable development has profound implications for the real estate industry. The role of the real estate sector in the process of sustainability and the complex relationship between the built environment and the pillars of sustainability (economic, environmental and social) have been accentuated over time, as an effect of Agenda 21 (the Earth Summit, Rio, 1992). Considered the most comprehensive test of operations realization of sustainable development in the 21st century, Agenda 21 emphasized the active co-responsibility of all sectors of activity, the recognition of the importance of all stakeholders ("Major Groups") and public–private partnerships in the implementation of action plans for sustainable development at the local level. Specific to Agenda 21 is the holistic approach to the concept of sustainability, meaning development based on the perpetual balance of the "three Ps" (Profit, Planet, People) [13], known as the "triple bottom line (TBL)" approach to sustainability.

Under the impact of Agenda 21, the real estate sector had to be involved in the process of understanding and adapting the principles of sustainability to its specific context. Thus, in 1999, the International Council for Research and Innovation in Building and Construction (CIB) published Agenda 21 on sustainable construction [14]. Considered a reference for the sustainable development of the construction sector globally, the document explains concepts ("sustainable settlements/cities", "urban sustainability", "sustainable construction", etc.), discusses the future of research and development in the field and details issues, challenges and action strategies for the construction industry.

Traditionally, the construction industry has based its business strategy mainly on the economic dimension of sustainability [15]. The supply of real estate correlates to a greater extent with short-term yields to the detriment of social and environmental aspects that generate long-term benefits to all stakeholders in the design, construction and management of the built environment [15]. Profit-based culture, where the control of costs, quality and time to complete real estate investments are the determinants that ensure maximum benefits to construction companies, should be enhanced in the perspective of the "triple bottom line" with the evaluation of benefits and costs of projects for society and the environment [16]. In relation to the TBL approach, sustainable development in this sector largely overlaps with sustainable construction, which involves integrating environmental, social and economic commitments into the full construction cycle, from raw material extraction, building design and construction of the infrastructure, to the final deconstruction and management of the resulting waste [17].

The economic aspect of sustainability in construction, according to the TBL concept, emphasizes the creation of prosperity for all, within the ecologically possible limits, ensuring quality of life through a healthy built environment, and providing satisfaction in the interactions with stakeholders. From an economic point of view, sustainable constructions generate higher internal profitability rates for responsible investors by minimizing the total costs of the construction life cycle (efficient use of buildable land, innovative construction materials, modern technologies, minimizing waste by recycling of demolition materials) and lower risk premiums. Goubran et al. [12] document that sustainable real estate investments lead to more than cost savings for the commercial real estate sector by the increase in the market value of these assets. The financial efforts made by developers to reduce the negative impact of the real estate industry on the environment, and by owners to increase the energy efficiency of homes, give rise to costs that are capitalized in higher rental/sale prices through a green premium [18]. Being aware of the financial benefits [19], health and productivity of sustainable buildings, tenants are increasingly demanding that their green functions be included in their leases [20]. According to the meaning of the economic

dimension of the "triple bottom line" model, the real estate industry is sustainable if it adds economic value to the environment in which it operates and grows.

The real estate sector is largely to blame for the degradation of the environment and health, heavily using non-renewable natural resources and energy-consuming materials, affecting land management and producing solid waste, dust emissions, greenhouse gases and other negative externalities [1]. The World Economic Forum [21] estimates significant increases in the global carbon and greenhouse gas footprint, given the increasingly urban nature of the world's population by 2030, when the world's 750 largest cities will require 260 million new homes and 540 million square feet of new office space. However, the environmental aspect of sustainability in the construction industry has evolved amid climate change and global warming, transforming from a niche into an approach that developers and consumers of sustainable real estate adopt in the phases of design, construction, use and even demolition of buildings [12,22]. Analyses of climate change mitigation policies have highlighted that the construction sector has great potential to save energy and reduce greenhouse gas emissions. Moving to new or renovated homes consuming less energy or producing more energy than consumed thanks to innovations in the development of building materials and renewable energy, and the carbonization of energy production, can reduce greenhouse gas emissions [23]. Rahdari and Rostamya [24] point out that the real estate industry has a fiduciary duty to implement the Paris Agreement. Consistent with this statement, an intensification of the global trend of the construction industry to "green", worldwide proliferation of building evaluation systems according to sustainability attributes [25] and a growing interest in certifying the energy efficiency of buildings [26] become significantly visible. Strauss [27] notes that over the last ten years, the issue of building stock sustainability has become a consistent element of EU environmental and energy policy. Despite this fact, the definition of sustainable building remains largely focused on the issue of energy efficiency of buildings [27]. Issues such as the recycling of materials from demolition, seismic resilience, waste management and water quality are barely addressed in the legal and mandatory framework designed by the EU [28].

In the TBL vision of the social dimension, the real estate sector is called upon to respond to increasing accessibility of housing to the population and future demographic needs. The World Economic Forum [21] estimates that by 2030, 66% of the world's population will be urban, and people over the age of 65 will predominate as a share of the world's population, driving demand for multi-residential real estate. Sustainable real estate can serve as a vehicle for social and economic inclusion, as it creates job opportunities in: design, construction, landscaping, materials production, energy efficiency, recycling and waste management, etc. The benefits of sustainable buildings include improving the health and working conditions of occupants, their productivity and their quality of life. Despite these potential benefits, economists acknowledge that some market or industry failures lead to under-supply of sustainable buildings. Market failures stem from asymmetric information. High initial costs, lack of political support, financial and time pressures, the unique context of each construction project and the large number of stakeholders are obstacles that discourage contractors from being involved in applying the principles of sustainability in real estate [12,29].

The TBL model has undergone further developments, so that today the current concept of sustainable development includes, in addition, a number of key elements related to ethics, spiritual and cultural values and governance [30], describing sustainable development in four dimensions ("quadruple bottom line" (QBL)): Profit, Planet, People, Purpose.

The QBL reveals the whole set of values and processes that make sustainable development an effort to achieve the 17 Global Sustainable Development Goals (SDGs) proposed in 2015, which contained the United Nations 2030 Agenda for Sustainable Development [22]. In line with the 2030 Agenda, professional bodies in the field of real estate (e.g., Housing Europe) have developed strategies for: investing in affordable, decent, healthy and safe housing for all residents in order to increase social welfare (corresponding to SDG 1—No poverty and SDG 3—Good health and well-being); building new homes and refurbish-

ing existing ones to become energy independent and energy efficient (according to SDG 7—Affordable and clean energy); improving the quality and safety of residential neighborhoods and reducing urban congestion (corresponding to SDG 11—Sustainable cities and communities) [31].

Achieving these goals requires the concerted efforts of governments, the business community, civil society and citizens, i.e., institutions responsible for ensuring stability, democracy, participation and the rule of law. Researchers increasingly refer to institutions as the "deep" determinants of well-being and economic growth, with a key role in creating a non-discriminatory and inclusive environment [32,33]. The role of institutions is to ensure order, to reduce uncertainty in exchange relations and to create stable structures to stimulate economies [34]. Charron and Lapuente [35], starting from North's hypotheses, argue the correlation between the quality of institutions (reduced corruption, impartiality and transparency in governance, effective public policies, the rule of law, protection of property rights) and well-being of a community (health of the economic system, occupational and social protection policies, educational level, etc.).

Regarding the real estate industry, there are many institutions that make possible the relatively efficient functioning of real estate markets, ensure the security of property rights, increase the transparency of transactions for buyers and sellers, create the necessary framework to intensify the flow of foreign direct investment, etc.

2.2. Theoretical Substantiation of the Link between Residential Property Prices and the Dimensions of Sustainability. Development of Hypotheses

The theory of residential real estate markets argues that prices are very sensitive to demand shocks [4]. Naturally, the sustainable development of real estate is primarily driven by demand, and when users are not attracted to market goods, investors, developers and builders re-evaluate business models [36]. The problem is that most of the time investors associate high costs with sustainable buildings, compared to the expected profitability [36]. For example, maintenance costs (especially energy costs) are reduced after rehabilitations are carried out for sustainable purposes and generate savings for tenants or landlords [5,6]. These savings are, however, the result of prior investments, which involve increasing the value of capital invested in property, including through a premium that captures the difference in value between sustainable and standard buildings. For the resulting savings, users will pay higher rents or prices, of the premium type, correlated with the comfort of the building. Therefore, green premium expresses the willingness of end users to pay more in relation to the market reference price for their sustainability characteristics and for better control of the associated risks, such as the risk of rising energy prices. In fact, green premium is the effect of the demand for sustainable buildings above supply. Unfortunately, the former is not permanent and may diminish or "evaporate" when market standards change, depending on how quickly the local market adapts to new market conditions [7]. The market value of residential properties is dictated, in particular, by the ability of tenants and buyers to pay, in correlation with their perception of the attributes that real estate possesses. Therefore, demand may perceive the benefits of sustainable buildings, but it may be constrained by available financial resources. These constraints caused by socio-economic inequality affect housing inequality [37]. Most of-ten, countries with high levels of inequality face major problems of overcrowding and homelessness [38]. The real estate sector plays an important role in addressing social challenges, and public policies are beginning to recognize this reality.

The supply of residential real estate assets depends on the reaction of developers to market price fluctuations, which also correlate with the state of the economy. During periods of economic recovery, demand for housing increases, putting pressure on prices and increasing the response rate of developers through a new supply, and during recessions, when demand decreases, existing supply reaches equilibrium or exceeds demand [39]. Such behaviors generate asymmetric responses in residential markets, with elastic reactions of housing supply during economic booms and inelastic reactions during periods of economic decline [40]. The inability of prices to adjust quickly to market fundamentals is a

considerable indication of the inefficiency of the real estate market [4]. According to the equilibrium model developed by DiPasquale and Wheaton [11], the prices of residential properties should reflect their housing or reconstruction costs along with the market value of the land, the cost of obtaining cadastral documentation and other costs determined by some urban restrictions, which influence the delivery speed of new constructions [41].

Real estate market prices provide information that guides developers in the realization of residential real estate projects with attributes of sustainability. The location of a building is fundamental in determining its price [42]. The immovable character contributes to the increase in the sensitivity of the residential buildings to externalities. Externalities are prevalent in residential real estate markets [42] and can have negative or positive effects on the built environment. Negative externalities in residential areas come from noise from air traffic [43], rail and roads [44], high crime in the area [45], construction waste [46], environmental hazards, proximity to hazardous waste landfills [47], etc. The positive externalities come from the areas with green spaces [48] and anthropic lakes for recreation (urban wetlands) [49], from investments in the maintenance of residential buildings in the area [42], from the proximity of public transport employment, educational institutions and commercial areas [50], etc. The effect of negative externalities is reflected in lower residential property prices in problematic areas, while positive externalities contribute to higher prices. Due to quantification difficulties, many of the effects of externalities are not integrated into the traditional pricing mechanism [42]. Sustainable development contributes to capturing externalities in market prices, boosts investment in alternative technologies that mitigate the negative impact of externalities [9] and stimulates the willingness of tenants to pay a higher price for more sustainable housing.

Economic growth supports sustainability policies and is a precondition for the sustainable consolidation of communities, even if it is responsible for the degradation of the environment. At the same time, sustainable development is conditioned by the quality and functionality of institutions (rule of law, political stability, government effectiveness, control of corruption, regulatory framework, property rights and rule-based governance), which largely explain the differences in the level of development between the world's economies [34,35]. Developed countries are more likely to implement sustainability policies at a national level and to spread their effects, unlike underdeveloped countries, with more vulnerable institutional systems.

EU countries are among the countries that contribute the most to the achievement of the SDGs, with around 80% of the targets set [28] to date. A ranking of countries according to the SDG Index values, which assess the performance of countries in the responsible application of the SDGs, places Sweden, Denmark, Finland, Germany and France in first place, with scores of over 80 points out of 100. Among the Eastern European countries, Slovenia, the Czech Republic, Estonia, Croatia and Slovakia stand out with index values between 75 and 80 points out of 100 (Figure 1), along with Ireland and Luxembourg, although the latter are the EU countries with the highest gross domestic product per capita.

The same ranking of EU countries is noticeable in terms of the quality of institutions, according to the European Quality of Government Index [35]. Therefore, institutional sustainability cannot be separated from the other dimensions of sustainability [51] nor neglected in the study of price dynamics in residential markets.

Based on the above considerations, we propose testing the following working hypotheses:

Hypothesis 1. *The price of residential properties reacts to the attributes of sustainability dimensions (economic, social, environmental and institutional).*

Hypothesis 2. *There is a significant link between housing price dynamics and the economic and social dimensions of sustainability.*

Hypothesis 3. *Economic, social and environmental dimensions of sustainability determine the variation of prices on residential real estate markets.*

Hypothesis 4. *The quality of the institutional environment, alongside the economic, social and environmental dimensions of sustainability, influences the formation of residential property prices.*

Hypothesis 5. *The capitalization of sustainability attributes in residential property prices is more evident in EU countries considered leaders in sustainability than in EU countries that are less committed to sustainable development.*

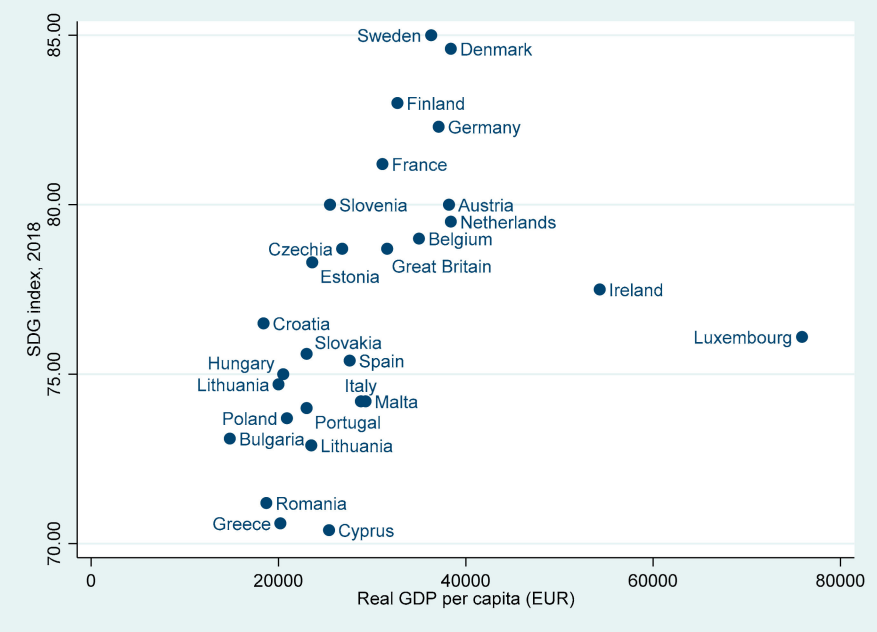


Figure 1. Sustainable Development Goal (SDG) average score for achieving sustainability objectives in relation to economic development in European Union countries. Authors' projection based on Eurostat data (code: nama_10_pc) and the SDG Index 2018 (http://www.sdgindex.org/, accessed on 20 September 2020).

3. Materials and Methods

3.1. Modeling Approach and Econometric Strategy

The empirical analysis measures the impact of the four dimensions of sustainability (economic, social, environmental and institutional) on the dynamics of residential property prices in EU-28 countries. The starting point is represented by two general models that explain the formation of prices in residential markets, namely, Quigley's model [10] and DiPasquale and Wheaton's (DW) model [11]. Both models designate as market fundamentals of housing prices only the economic and social factors that belong, in fact, to the two dimensions of sustainability. The model proposed by Quigley is reflected by Equation (1), in which HPI_{it} represents the prices of residential properties in country i in period t, which determines the equilibrium between the demand (Q_{it}^{d}) with the supply (Q_{it}^{s}) of housing.

$$HPI_{it} = f\left(Q_{it}^{d}, Q_{it}^{s}\right) \quad (1)$$

The demand for housing (Q_{it}^{d}) depends on the disposable income of the population $(Income_{it})$, the prices of residential properties (HPI_{it}) and a vector of exogenous variables (X_{it}) (Equation (2)). The supply of living space (Q_{it}^{s}) depends on house prices (HPI_{it}), the rate of unoccupied buildings $\left(Im_{unoccupied_{it}}\right)$ and other exogenous variables (Y_{it}) (Equation (3)). The demand for properties will increase with an increase in income,

but it will decrease following price increases, while the supply will increase with the prices and will decrease with a high degree of vacancy of the living spaces.

$$Q_{it}^{d} = f(HPI_{it},\ Income_{it},\ X_{it}) \tag{2}$$

$$Q_{it}^{s} = f\left(HPI_{it},\ Im_{unoccupied_{it}},\ Y_{it}\right) \tag{3}$$

As the literature does not provide an inventory of the exogenous variables X_{it} and Y_{it} in Equations (2) and (3) [10], their choice is supported by the idea that house price dynamics are strongly associated with macroeconomic variables, real estate market conditions and the means of real estate financing [52].

In DiPasquale and Wheaton's (DW) model [11], the equilibrium between demand and supply of residential property depends on economic conditions and rents. The favorable economic conditions reflected in the high degree of employment, the increase in disposable income and the high volume of industrial production contribute to the amplification of the demand for space [11]. A higher stock of square meters means a low level of occupancy, which leads to lower rents. According to the DW model, the price of housing is formed by capitalizing rents at a capitalization rate that represents the current return required by an investor to own a real estate asset.

Starting from the previously described models, we developed a general model for analyzing the sensitivity of residential property prices to the economic and social dimensions of the market (Equation (4)). Subsequently, by successively integrating the other dimensions of sustainability (environmental and institutional) in the general reference model, we developed two other models in line with the triple bottom line and quadruple bottom line visions on sustainability, to capture the reaction of residential property prices (Equations (5) and (6)).

$$HPI_{it}(E\&S) = f(Economics_{it},\ Social_{it}) + \varepsilon_{it} \tag{4}$$

$$HPI_{it}(TBL) = f(Economics_{it},\ Social_{it},\ Environment_{it}) + \varepsilon_{it} \tag{5}$$

$$HPI_{it}(QBL) = f(Economics_{it},\ Social_{it},\ Environment_{it},\ Institutional_{it}) + \varepsilon_{it} \tag{6}$$

The quantification of the formation of house prices under the incidence of the dimensions of sustainability involved the development of the research in two stages. In the first stage, the proposed models were applied to the entire population of the EU-28 Member States, in the period 2000–2018. Even if the EU is actively committed to implementing the 2030 Agenda by integrating all SDGs into its policies and priorities, the degree of involvement in sustainable development varies from country to country. In other words, sustainable development represents a "mosaic reality" [1] (p. 25) at the EU level. For this reason, in a second stage, we investigated the existence of capitalization differences in the size of sustainability in residential market prices, depending on the degree of involvement of EU countries in the transition of the SDGs over the analyzed period. The differentiation of the states was based on the SDG 2018 Index with a median value equal to 76.3 which divided the population of EU Member States into two groups of 14 countries. According to the SDGs, Sweden, Denmark, Finland, Germany, France, Slovenia, Austria, the Netherlands, Belgium, the Czech Republic, the United Kingdom, Estonia, Ireland and Croatia form the group with the strongest commitment to sustainable development, and Luxembourg, Slovakia, Spain, Hungary, Latvia, Italy, Malta, Portugal, Poland, Bulgaria, Lithuania, Romania, Greece and Cyprus are part of the group of countries with a lower rate of SDG implementation.

The collected data were organized in the form of a panel. The estimation of panel-based econometric models is preceded by the testing of stationarity at the level of the whole panel (panel unit root) and of each variable, testing of co-integration relations and determining the appropriate effects of the model (fixed or random). Thus, the Levin, Lin and Chu (LLC) test for stationarity was applied, as recommended for cross-country

studies [53], and the testing of the stationarity of each variable was performed according to the Schwartz criterion, with maximum lag lengths. The existence of co-integration relationships between the variables of sustainability models was verified by panel co-integration tests, considered more efficient procedures than individual testing of each time series [54], by applying the Kao test [55], based on the Engle–Granger procedure. To ensure the linearity and normality of data, most variables were converted to natural logarithm form.

As the panel is made up of EU countries with heterogeneous real estate markets, determined by the invariant characteristics specific to each state, it is necessary to control spatial heterogeneity through fixed effects, whose parameters capture both regional, time-invariable differences and other unobservable components that may influence market prices. The adequacy of fixed effects in sustainability models was validated by the Hausman test [56].

Some variables may capture the same type of information, manifesting two-dimensional relationships, such as energy consumption and gas emissions [6], and house prices and income inequality, which generates problems of multicollinearity and endogeneity in estimating housing price equations according to the dimensions of sustainability. The traditional ordinary least squares (OLS) method is inefficient in reducing the effects of multicollinearity and endogeneity, requiring the use of more robust alternative methods, such as two-stage least squares (2SLS) [6], by instrumenting all right-hand regress factors with their own lags [54].

Taking into account the abovementioned econometric specifications, the models of house price sustainability (HPI_{it}), estimated using the 2SLS method, can be rewritten as follows:

$$HPI_{it}(E\&S) = \alpha_{it} + \sum_{i=1}^{n} \beta_{1it} Economics_{it} + \sum_{i=1}^{n} \beta_{2it} Social_{it} + \sum_{i=1}^{n} \gamma_i FE_i + \varepsilon_{it} \quad (7)$$

$$HPI_{it}(TBL) = \alpha_{it} + \sum_{i=1}^{n} \beta_{1it} Economics_{it} + \sum_{i=1}^{n} \beta_{2it} Social_{it} + \sum_{i=1}^{n} \beta_{3it} Environment_{it} + \sum_{i=1}^{n} \gamma_i FE_i + \varepsilon_{it} \quad (8)$$

$$\begin{aligned} HPI_{it}(QBL) = \alpha_{it} &+ \sum_{i=1}^{n} \beta_{1it} Economics_{it} + \sum_{i=1}^{n} \beta_{2it} Social_{it} + \sum_{i=1}^{n} \beta_{3it} Environment_{it} \\ &+ \sum_{i=1}^{n} \beta_{4it} Institutional_{it} + \sum_{i=1}^{n} \gamma_i FE_i + \varepsilon_{it} \end{aligned} \quad (9)$$

where: the matrices $Economics_{it}$, $Social_{it}$, $Environment_{it}$ and $Institutional_{it}$ include the variables specific to each dimension of sustainability. The intersection of the equations is divided into the constant α_{it} and the invariable term specific to each country $\sum_{i=1}^{n} \gamma_i FE_i$. The parameter γ_i captures the individual effects FE_i of the invariant characteristics specific to each country (location, environmental conditions, local conditions, etc.). ε_{it} is the error term. In all equations, i is the EU-28 member country and t is the time period (year).

3.2. Variables and Data

The dependent variable, the price of real estate (*HPI*), and the independent variables that characterize the dimensions of sustainability are presented in Table 1.

The analyzed period is 2000–2018, adjusted according to the data availability. The lack of real estate data covering long time horizons remains a major problem, especially for the post-communist countries, reflecting the lack of transparency of some real estate markets [57]. For this reason, the data were collected from different sources, taking into account the calculation methodologies of the indicators of interest to ensure the comparability and homogeneity. The data sources are databases of: Eurostat, European Central Bank, European Mortgage Federation, World Bank and DG Taxation and Custom Union.

Table 1. Description of the variables.

Variables		Description	Data Source and Period
Dependent	Prices of residential properties (*HPI*)	Variation of the real price of new and existing residential properties (apartments, individual houses, etc.) purchased by households (%)	Eurostat (code: tipsho10), 2000–2018
Economic	The cost of building residential properties (*CCRP*)	Variation of the real cost of building new residential buildings (%)	Eurostat (code: sts_copi_a), 2000–2018
	Authorizations issued for residential constructions (*BPRP*)	Variation in the number of permits issued for housing construction (%)	Eurostat (code: sts_cobp_a), 2000–2018
	Rent for housing (*RENTs*)	The variation of the effective rent for housing, component of the harmonized index of consumer prices CP041 (%)	Eurostat (code: prc_hicp_aind, 2000–2018
	Interest rate (*IRR*)	Real interest rate on new home loans (%)	European Central Bank and Hypostat, 2000–2018
	Unemployment rate (*UNEMP*)	Share of unemployed persons in the total resident population aged between 20 and 64 (%)	Eurostat (code: lfsi_emp_a), 2000–2018
Social	Income inequality (*GINI*)	The disproportion of the income distribution of the population measured by the GINI coefficient, which takes values from 0 to 100, where 0 means perfect equality and 100 expresses total inequality	Eurostat (ilc_di12), 2000–2018
	Population density (*PPDnst*)	Population's concentration on a 2 km land area	World Bank (code: EN.POP:DNS), 2000–2018
	Housing costs (*HSGCost*)	Share of total expenditure allocated for housing maintenance (mortgage interest, rents, insurance, taxes, fees, utilities, etc.) in disposable household income (%)	Eurostat (code: ilc_mded01), 2004–2018
	Housing deprivation (*HSGDep*)	Share of households with dependent children living in overcrowded housing, physically depreciated (problems with the foundation, walls, floor, roof, etc.) and/or functionally depreciated (lack of basic sanitation) in the total household population (%)	Eurostat (code: ilc_mdho06b), 2003–2018
Environmental	Energy consumption (*EngRes*)	Energy and heat consumption per household member (kilogram of oil equivalent/person)	Eurostat (code: SDG_07_20), 2000–2018
	Generated waste (*Waste*)	Quantity of waste from construction, demolition, repair and landscaping (kg/inhabitant)	Eurostat (code: env_wasgen), 2000–2018
	Living environment (*LivEnv*)	The share of people who face negative externalities (pollution, grime or other environmental problems), in the area where they live, in the total population of households (%)	Eurostat (code: ilc_mddw02), 2003–2018

Table 1. *Cont.*

	Variables	Description	Data Source and Period
Institutional	Transactional costs (*TrCost*)	Share of costs related to real estate transactions (stamp duties, taxes on income from the transfer of property, capital taxes, etc.) in the total value of taxes collected (%)	European Commission, *DG* Taxation and Customs Union, 2000–2018
	Governance efficiency (*WGI*)	Arithmetic mean of the indicators' voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption, which takes values from −2.5 to 2.5	World Bank's Worldwide Governance Indicators 2000–2018

Table A1 in Appendix A reflects the descriptive statistics for the selected variables for the 28 EU Member States. Residential real estate prices have generally followed an upward trend. Since the mid-1990s, a boom episode has been common for almost all countries, ending with a sharp correction in real house prices around 2007–2008, i.e., almost 10–15 years after its inception [58]. Over the whole period under review, the annual growth rate of HPI at the EU level peaked at 9.9% in the first quarter of 2007 and reached a low of −6.0% in the second quarter of 2009. This synchronization in the emergence of the bubble and in its bursting provides an initial evidence of the role played by global fundamentals in shaping dynamics of housing prices [58].

3.2.1. Economic Dimension

In order to express the economic dimension of sustainability in real estate, independent variables were selected to characterize the supply of residential properties (residential construction costs—*CCRP* and permits issued for residential constructions—*BPRP*) that meet market demand (housing rents—*RENTs*, interest rate—*RIR*, unemployment rate—*UNEMP*) (Table 1).

The supply of new real estate assets comes from the construction sector and depends on the cost of construction, replacement or reconstruction of these assets [59] and the availability of land for new residential construction, quantified by the permits issued [54]. Construction costs (*CCRP*) and permits for new residential buildings (*BPRP*) are the variables most used by researchers in econometric models to express the supply of housing and, implicitly, to monitor the reaction of the residential market price [52,54]. High construction costs raise sales prices, affect the volume of residential real estate investments, reduce supply and inhibit demand over time. The descriptive statistics reveal an average variation of real construction costs for residential buildings (*CCRP*) of 99.98%, just below the reference level of 100%, which illustrates a relative stability over time of the real costs required for housing construction. The increase in the number of permits issued (*BPRP*) is for real estate developers a signal of expanding demand in real estate markets, which contributes to higher prices. At the same time, the simplification of the conditions for granting building permits leads to a reduction in long-term housing prices [54], a situation that can be mitigated by structural zoning, planning and construction policies [60]. The boom period that preceded the financial crisis from 2008 to 2009 was also reflected in the high volume of residential construction, as evidenced by the average variation of the indicator (*BPRP*), equal to 220.94%, and the corresponding standard deviation equal to 331.87%.

One of the motivations that determines the demand for residential property is the desire to obtain a fixed income through rent. The level of rents (*RENTs*) and the yield on rents provide important indications of demand. The prices of residential goods depend, to a large extent, on their rental value. When the rental yield is higher compared to the interest on the banking market [61], it is more advantageous to be a home buyer/investor

than a tenant. In the residential market, there is naturally a continuous adjustment between the purchase price and the level of rent.

For the majority of the population, housing is the main asset held, and the mortgage is the main debt. Therefore, significant movements in house prices affect the net worth of households, and their ability to borrow can have important macroeconomic implications, especially on consumption and bank soundness [62]. By using the value of their home as collateral, households can borrow more and relax loan constraints, indirectly fueling the real estate price boom [58]. Real interest rates (*IRRs*) are therefore able to warn ex ante movements in real estate prices [58]. In general, declining interest rates reduce the cost of borrowing households, encourage demand for owner-occupied housing, driving up prices. At the same time, there is a change in portfolio, in the sense that investments in rental properties become relatively more attractive as the interest rate decreases and as the returns on alternative investments decrease [63]. Many authors [64,65] conclude in their studies that house prices correlate negatively with the interest rate.

The literature mentions the strong negative link between house prices and the unemployment rate (*UNEMP*). Xu and Tang [64] and Özmen et al. [65] document that the rising unemployment rate is leading to an increase in the share of low wages in the economy and adds uncertainty about the future income of the population, creating the conditions for reducing consumption in all categories of goods and, in particular, for residential properties. In turn, the unemployed who are unable to repay mortgages are forced to sell their homes, which intensifies the fall in property prices [66].

3.2.2. Social Dimension

The size of the population's income is the expression of the purchasing power which, on the residential market, conditions the accessibility of housing [67]. The literature in general indicates the direct link between income and prices in the residential market. Encinas et al. [68] records the increased interest of the population with higher purchasing power in the acquisition of real estate that has the attributes of sustainability. However, there are also studies that empirically contradict the positive connection between populations' income and residential prices. Pour et al. [69] discover the negative relationship between house prices and incomes in Iran, explained by intensified construction activity in periods characterized by real economic growth. Xu and Tang [64] also provide evidence for the negative relationship between disposable income and house prices in the UK between 1971 and 2012, arguing that this was due to conflicting consumer choices for real estate investment or other investments/expenditures.

Motivated by the contradictory results in the literature on residential markets, there are authors who study the reaction of prices in residential markets not only to income, but to the inequality of income distribution. Reducing income inequality is one of the 17 global goals of sustainable development, represented by SDG 10—Reduced Inequalities. The inequality index (*GINI*) seems to be the most illustrative to assess the extent of income segregation, with values ranging from 0 or 0% (perfect equality in income distribution) to 1 or 100% (perfect inequality), which explains its frequent use in empirical models. The savings made by the high-income population, to the detriment of real estate investments, and the weak purchasing power of the low-income population, which needs housing, diminish the demand and prices of residential goods. In a recent contribution, Kösem [70] explains the negative impact of income inequality on US house prices, arguing that access to mortgages partially mitigates the negative impact and restores the functioning of the housing market by eliminating imbalances. Following the same line, Özmen et al. [65] provide empirical evidence on the impact of income inequality on housing price dynamics from the perspective of an emerging economy. Policies aimed at improving income equality can help alleviate imbalances in the residential market [71].

Residential property prices are quite sensitive to demographic change [67]. The influence of population density (*PPDnst*) on housing price dynamics is ambiguous, because, on the one hand, large agglomerations can limit the activity of the construction sector, and

on the other hand, they can stimulate developers to build more and more blocks of flats and few single-family homes. Agglomeration, especially in the urban environment, is one of the major concerns of sustainable development. According to urban theory, the increase in population density in the urban environment leads to the demand for housing, which often determines the expansion of the urban area [72], with favorable consequences on the price on the residential market.

Housing maintenance costs (*HSGCost*) raise the selling price of residential property [73]. These costs are the expression of the total operating expenses of the dwelling, including the amounts spent to cover the consumption of water, energy, repair and replacement of some elements and expenses for waste management, insurance and land taxes throughout the life of the dwelling or within a specified range. The share of these costs in the disposable income of households indicates the accessibility of housing. According to descriptive statistics estimated on the basis of Eurostat data, for the analyzed population, housing maintenance costs represent on average 20.6% (±6%) of the household's disposable income.

Housing prices are one of the best reflections of the challenges that citizens are facing in some countries [67]. Deprivation of housing (*HSGDep*) highlights the problems of people living in overcrowded, physically and functionally deprived areas (damaged roofs, lack of sanitary spaces, lack of natural light). SDG 1—No Poverty and SDG 11—Sustainable Cities and Communities promote the global need to provide adequate housing to build a sustainable future. Housing deprivation is a social problem with unfavorable consequences on the demand and price of housing. For the analyzed period, the number of households co-living and deprived of adequate living conditions represents, on average, 8.60% of the total EU-28 households, with a standard deviation equal to 8.92%, which indicates the high level variation of the indicator within the sample. In 2018, Romania recorded the highest deprivation rate of 22.8%, followed by Latvia with 20.4%, Bulgaria with 15%, Hungary with 11.4%, Lithuania with 11.2%, at the opposite pole being Finland with 1%, Ireland with 1.2%, the Netherlands with 1.4% and Cyprus with 1.8%.

3.2.3. Environment Dimension

Over recent decades, several policies have been developed in the European Union to improve the environmental performance of the housing stock, focusing in particular on the energy certification of buildings. Energy conservation and energy efficiency have been the gateway to sustainable construction in the residential markets [5]. In the literature, the ways in which residential market prices reflect the reduction of energy consumption (*EngRes*) or the improvement of energy efficiency are analyzed in correlation with supply and demand. From a supply perspective, energy efficiency is the result of interventions in the structure of housing, to create environmentally friendly facilities that reduce energy consumption, thus lowering the costs of services that are capitalized in residential property prices through a green premium [74]. From a demand perspective, low residential energy consumption stimulates buyers' willingness to pay more for efficient buildings, which leads to rising prices, enough to offset production costs, encourage developers and alleviate real estate market volatility [5]. Taltavull de La Paz et al. [6] identify in the literature three ways in which it is assumed that reducing energy consumption could affect final selling or rental prices: (1) energy costs are reduced after a home remodeling intervention, which generates a saving for the tenant or landlord, which is passed on to the rental/sale prices; (2) because the energy saving is obtained by investing additional capital in the house, the green premium captured in the higher value of the house reflects this investment effort; (3) consumers' preference for green housing and willingness to pay for green features make the difference between prices/rents on the market.

The residential sector is also known for the large amount of waste from construction, demolition, repair and housing development (Waste), which represents about 25–30% of total waste generated in the European Union [75]. For the analyzed population, the average amount generated by such waste is equal to 403.5 kg/inhabitant, with a large

standard deviation of 116.25 kg/inhabitant. Due to their non-combustible and generally non-biodegradable nature, most of this waste requires storage in spaces that sometimes occupy valuable land, which could receive another utility. There is also a risk that the resulting waste will pollute the air, water and soil due to the production of carbon dioxide, methane, dust emissions and leachate [46,75]. Minimizing the negative impact of construction waste, demolition, repair and landscaping on the environment, through efficient management and other innovations specific to the circular economy, is stipulated in the Green Building Rating and Certification Systems. The re-use and recycling of construction waste has become a global task. International concerns about waste management are materialized in SDG 12—Responsible consumption and production.

Studies that analyze the influence of local factors on residential prices consider the quality of the residential area as an essential criterion in choosing homes and setting the price of residential goods. As stated above, there is empirical evidence that unwanted externalities, such as noise caused by rail, air or other heavy infrastructure traffic, poor water and air quality in the area of residence, the existence of hazardous landfills, drug trafficking, vandalism, risk of catastrophe, etc. negatively affect housing prices [67]. Other research reveals that neighborhood factors and the condition of the residential area are associated with residential satisfaction/dissatisfaction, which initially causes residents to pay more for reduced levels of pollution, noise and other negative externalities or move to other areas [76]. The greater the uncertainty of the buyer, the lower the value of the asset [34]. For this purpose, we selected the variable local environment (*LivEnv*), which expresses the percentage of people who face various forms of negative externalities in the area where they live, to highlight the influence of the quality of the residential area on housing prices.

3.2.4. Institutional Dimension

Institutions, according to North's definition [77], represent a combination of formal rules (constitutions, laws, property rights, etc.) and informal constraints (rules of conduct, conventions, codes of conduct, etc.). Formal rules are created by the state, in order to shape/adjust human interaction, and can be changed "overnight", as a result of political or legal decisions. Informal constraints are part of the legacy called "culture of a society", they change gradually because they are much more impervious to deliberate policies, but they matter in the evolution of the institutional framework [78]. Institutions are the "rules of the game" in society, and organizations (political, economic and social) are the players whose results depend on the opportunities offered by the institutional framework (order, rule of law, stability, democracy, participation, economic freedom, reduction uncertainty in trade relations, stimulating economies, etc.) [76].

For the real estate industry, the strong institutional environment is associated with: greater freedom in business, rigor of the regulatory process, reduced corruption, legal protection of private property rights, a wide range of intermediation services and a favorable environment for sustainable real estate investments [79]. Weak institutions exacerbate the risks of real estate investments and diminish their operational efficiency, having accentuated negative effects in this industry due to the long duration of recovery of investments and the low liquidity of the market.

As the economic reality of recent decades has shown that the dynamics of real house prices are not only influenced by the fundamental factors of supply and demand, but also by the structural features of the institutional framework in which entities and citizens operate [80], we introduced in the analysis a variable for governance efficiency (*WGI*). Governments intervene in residential real estate markets in order to fairly increase the population's access to housing through various fiscal measures (reductions in taxes, etc.), the distribution of social housing or the direct subsidization of rents, as well as through regulations that may influence the quantity, quality and price of housing [81].

Efficient governance keeps trading costs low, allowing demand and supply to react quickly to changes in the resident market, thus avoiding high price volatility, price de-

viations from short-term equilibrium, and extensive real estate cycles [54,80]. Following Helliwell and Huang [81], and Paterson and Charles [82], the *WGI* variable of the institutional dimension is appreciated by an arithmetic average of World Bank's Worldwide Governance Indicators: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption [83]. These indicators measure the efficiency of governance in units of a standard normal distribution, with a mean of zero, standard deviation of one and running from approximately −2.5 to 2.5, with higher values corresponding to better governance [83] (p. 9). The average value of the *WGI* variable for the analyzed period, 1.07 out of 2.5, indicates a relative degree of efficiency of governance at EU level. Above the average values of the *WGI* indicator, Finland (1.86 out of 2.5), Denmark (1.80), Sweden (1.76), Luxembourg (1.72) and the Netherlands (1.70) are characterized by the most effective governance systems. At the opposite pole are Italy (0.61), Greece (0.51), Croatia (0.39), Bulgaria (0.21) and Romania (0.09) with the weakest governance systems.

According to the neo-institutional theory, institutions influence the costs of owning and using a property, including transaction costs. According to North [34], transaction costs are the most observable dimension of the institutional framework, able to constrain the market exchange process. As real estate markets are characterized by heterogeneity, high decentralization and poor transparency, real estate transactions often involve high transaction costs, which are reflected in final sale–purchase prices [84]. The causes that determine unwanted trading costs by real estate developers and end users are: asymmetric and incomplete market information, unfair competition, aversion to the implicit trading risks and distortion of regulations. Basically, transaction costs include the costs of: searching for information, contracting and executing the project, covering various uncertainties in the development and management of assets (e.g., building land), adapting to new regulations, entering an unknown market, notarizing the transaction, etc. [84].

Trading costs determine the level of transparency of the real estate market, because the higher the costs, the lower the transparency of the real estate market and therefore the lower the efficiency of the market [85]. Thus, the inadequate alignment of existing market prices to the real value of real estate, justified by the fundamentals of supply and demand, contributes to the formation of major imbalances in the market. In order to capture the effect of transaction costs in residential real estate prices, we introduced in the analysis the variable transaction costs (*TrCost*), expressed by the share of costs related to real estate transactions (stamp duties, taxes on income from property transfer, capital taxes, etc.) in the total amount of taxes collected by the state budgets. In general, real estate transaction costs make a small contribution to the formation of the state budget, with the panel averaging 1.96%, and some Member States differing in higher average shares, such as Spain (4.73%), Belgium (4.13%), the United Kingdom (3.71%), Greece (3.61%) and Portugal (3.34%), in contrast to the eastern countries, where the average share of transaction costs is below 1%, for example: Romania (0.92%), the Czech Republic (0.90%), Lithuania (0.76%), Slovenia (0.51%), Estonia (0.25%) and Slovakia (0.24%).

The institutional environment can improve the disclosure of information and the transparency of the information flow necessary for the real estate trading process, by thoroughly regulating the field. Improving real estate transparency plays a central role in ensuring healthy, productive and competitive environments for the prosperity of communities and businesses.

4. Results and Discussions

4.1. Relationships between Sustainability Dimensions and Residential Property Prices

The results of testing the hypotheses regarding the assessment of the reaction of residential property prices to sustainability attributes are presented in Table 2.

Table 2. Estimates of the sustainability models.

Dependent Variable—*Ln(HPI)*				
Variables		***E&S* Model**	***TBL* Model**	***QBL* Model**
Economic	*Ln(CCRP)*	1.370 *** (0.172)	1.727 *** (0.204)	1.754 *** (0.201)
	Ln(BPRP)	0.147 *** (0.013)	0.145 *** (0.014)	0.138 *** (0.019)
	Ln(RENTs)	0.380 *** (0.039)	0.177 *** (0.068)	0.178 * (0.094)
	RIR	−0.002 (0.006)	−0.002 (0.014)	−0.005 (0.016)
	UNEMP	−0.010 * (0.005)	−0.010 *** (0.003)	−0.014 *** (0.005)
Social	*GINI*	−0.014 *** (0.005)	−0.014 * (0.008)	−0.011 (0.008)
	Ln(PPDnst)	1.001 *** (0.135)	0.973 *** (0.215)	1.140 *** (0.230)
	Ln(HSGCost)	0.409 *** (0.135)	0.394 *** (0.114)	0.501 *** (0.144)
	Ln(HSGDep)	0.060 *** (0.023)	−0.026 (0.024)	−0.021 (0.033)
Environmental	*Ln(EngRes)*		−0.240 * (0.168)	−0.096 (0.161)
	Ln(Waste)		0.063 (0.069)	0.104 (0.108)
	D(LivEnv)		−0.006 (0.006)	−0.001 (0.008)
Institutional	*D(TrCost)*			0.027 (0.024)
	WGI			−0.039 (0.095)
Constant C		−9.631 *** (0.952)	−8.901 *** (1.923)	−11.271 *** (2.165)
Cross fixed effects		Yes	Yes	Yes
Observations		362	330	330
Adj. R-squared		0.903	0.864	0.831
F-statistics		56.957 ***	49.194 ***	46.157 ***

Notes: E&S Model—environmental and social model; TBL Model—triple bottom line model; QBL—quadruple bottom line. Heteroskedasticity robust standard errors are presented in parentheses, and the statistical significance of the coefficients is interpreted as: *** p-value < 0.01 and * p-value < 0.1.

As expected, variables of economic and social dimensions of sustainability mostly determine long-term changes in house prices (*HPI*), which validate the general pricing models in residential markets, formulated by Quigley [10] and DiPasquale and Wheaton. [11]. Thus, our results support the second hypothesis on the significant link between house prices and the economic and social dimensions. Variables that reflect the economic dimension of sustainability, i.e., construction costs (*CCRP*), building permits (*BPRP*) and rent levels (*RENTs*), significantly affect the appreciation of house prices. The exception is the interest rate (*IRR*).

Real estate construction costs (*CCRP*) have a significant and strong influence on dynamics of housing prices. Higher costs for the construction of new residential properties,

caused by increased construction and/or labor costs, contribute to increased financing costs for new construction, which in the long run may diminish the new housing supply and, ceteris paribus, would generate higher prices on the housing market [11]. More precisely, an increase by 1% of the real construction costs would lead to an increase by 1.37–1.75% of the house prices. The variable of permits issued for residential construction (*BPRP*) has a positive and statistically significant influence on house prices (0.14–0.15%), which would mean that real estate developers perceive the availability of free land for construction as a signal of the expansion of real estate markets and real estate prices [54,86]. However, this real estate boom could be mitigated by certain structural policies on the environment, urban planning and construction [60].

The rental index (*RENTs*) positively influences the dynamics of residential property prices. The 1% appreciation of the rent index contributes to the increase in the house price index by 0.18–0.38%. The direct relationship between rent and house prices is explained by the fact that the level of rents, determined on the property market, immediately influences the demand for real estate on the asset market.

Although the literature documents the negative impact of interest rates on house prices, the intensity of the effect varies considerably depending on the sample and methodology [87]. The obtained results validate the negative effect of the financing conditions, expressed by the real interest rate on new housing loans (*RIR*), but without fulfilling the criterion of statistical significance. The weak and small influence ($\beta_1 = -0.002$ and -0.005) of the interest rate on residential property prices in all three models can be explained by the fact that at EU level real interest rates on housing loans are small and relatively stable [86], as shown by the average of the *IRR* variable of the sample equal to 1.84%. Even in the case of financing sustainable buildings, interest costs are similar to or sometimes lower than in the case of financing conventional buildings in order to boost sustainable construction [88]. Given the fragility of financial markets and interest rates at record lows, central banks have few options for lowering interest rates, having to explore innovative monetary policies to support the financing of sustainable projects under the European directives [89].

The unemployment rate (*UNEMP*) has a negative influence on the dynamics of house prices, thus affecting the number of potential home buyers, which confirms the results of other researchers [64–66]. In the E&S model, the coefficient of the *UNEMP* variable registers a negative and weakly significant value ($\beta_1 = -0.010$ *), but improves its significance in the TBL ($\beta_1 = -0.010$ ***) and QBL models that integrate all the dimensions of sustainability ($\beta_1 = -0.014$ ***). This means that increasing the unemployment rate by 1% can lead to a reduction in house prices by up to 1.4%.

From the social perspective of sustainability, only the *GINI* coefficient indirectly influences the prices of residential properties, while the rest of the variables—population density (*PPDnst*), housing maintenance costs (*HSGCost*) and housing deprivation (*HSGDep*)—directly determine the dynamics of house prices.

Inequality of income distribution, expressed by *GINI*, leads to a decrease in the trend of house prices, given the negative coefficients resulting from the run of sustainability models and the strong statistical significance of the coefficient ($\beta_2 = -0.014$ ***) in the E&S model. The indirect relationship between income inequality and house prices is demonstrated in other specialized works [65,70]. This result is due to the differentiated response of the demand for housing from different wealth groups to individual needs, which also influences the investment and saving decisions of households. The degree of income inequality in the EU-28 is moderate (according to the UN recommended limit: 40). The values of the GINI coefficient vary between 35.60 (Latvia) and 23.46 (Slovenia), and the average income at EU-28 level has an increasing trend, according to Eurostat. However, due to the global financial and economic crisis, the average rate of households' investment in residential properties decreased from 10.3% in 2007 to 8.2% in 2018, affecting the dynamics of housing demand.

The positive and significant influence of the population density (*PPDnst*) of 1–1.14% on house prices is explained, first of all, by the inelasticity of supply to the accentuated

demand coming from the inhabitants concentrated in the agglomerated areas and with economic potential. The inelasticity of supply is determined by limited land resources and urban and environmental restrictions, which affect the development of the housing stock needed to meet high demand.

According to the user cost of housing theory [73], housing maintenance costs (*HSGCost*) contribute significantly to rising house prices. The increase by 1% of the share of the costs necessary for the maintenance of the houses in the disposable incomes leads to an increase in the house prices by 0.4–0.5%, making the houses less accessible to the population. The attractiveness of owning a private home depends on the economic size of these costs [90].

The inaccessibility of housing is also highlighted by the positive influence of the variable that characterizes the deprivation of adequate housing for the population (*HSGDep*, $\beta_2 = 0.06$ ***) on the average housing prices in the E&S model. The increase in the percentage of the population living in overcrowded, physically and functionally deprived areas indicates a greater predisposition of this category of people to poverty, while accentuating the inequalities between rich and poor.

The variables referring to the environmental component of sustainability are reflected to a much lesser extent in the dynamics of average house prices in the EU-28, most likely due to the fact that the existing housing supply is still largely determined by the share of "unsustainable" properties in the total housing stock, whose prices are captured in average market prices. Subsequently, the third hypothesis is partially validated. Although of weak statistical significance, the negative sign of the energy consumption coefficient (*EngRes*, $\beta_3 = -0.240$ * and -0.096) supports the theoretical and empirical evidence of other researchers about the negative association between energy consumption and house prices [6,91]. The estimated parameters of the variable *EngRes* show that a 1% reduction in the amount of energy and heat consumed by each citizen within their own household contributes to an increase in residential property prices by 0.24%, so a green premium of only 0.24%. In general, specialized studies document the existence of low value green premiums, which contribute to the increase in house prices by 0.03–11%, depending on the location of real estate and the analyzed period [6].

According to the estimated results, the concentration of waste from construction, demolition, repair and landscaping per capita (*Waste*) is not reflected in the dynamics of house prices, given the lack of statistical significance in the TBL and QBL models of sustainability. Moreover, the parameters of the generate waste variable are not only insignificant, but also positive ($\beta_3 = 0.063$ and 0.104), contrary to the results of other studies [92]. The explanation could be related to the pressure exerted by the existence of a higher demand for housing in the EU-28 countries, which leads to the intensification of construction activity and real estate markets, with a direct impact on the amount of waste produced, but negligible from the perspective of price evolution.

Although the variable that characterizes residential areas exposed to environmental problems (*LivEnv*) is statistically insignificant, its parameters have negative values ($\beta_3 = -0.006$ and -0.001), confirming the results obtained by other researchers [67] that negative externalities in residential areas contribute to lower house prices in the area, as they affect the quality of life and lower the rating of the residential neighborhood.

The institutional dimension, expressed by transaction costs (*TrCost*) and governance efficiency (*WGI*), is not reflected in changes in housing market prices, given the lack of statistical significance of the parameters estimated in the QBL model, so the forth hypothesis is not confirmed. As trading costs are a feature of the transparency and efficiency of the real estate market, their influence on changes in real estate prices depends on the degree of transparency and efficiency of each market [85]. The positive value of the coefficient related to the variable *TrCost* confirms the theoretical statements about the capitalization of high transaction costs in the transaction prices of real estate. The same is true for the coefficient of governance (*WGI*) variable, which has a negative sign ($\beta_4 = -0.039$), meaning

that better management of public institutions ensures faster adjustment of real estate prices to market fundamentals [85].

4.2. Relationships between the Dimensions of Sustainability and Residential Property Prices According to the Degree of Commitment of EU States to Implementing the SDGs

Table 3 summarizes the results of measuring the impact of sustainability dimensions on house prices according to the degree of employment of EU countries in SDG implementation.

Table 3. Relationships between sustainability dimensions and residential property prices according to the SDG Index (median of 76.3).

Dependent Variable—*Ln(HPI)*							
		Countries with SDG Index > 76.3			**Countries with SDG Index < 76.3**		
Variables		***E&S* Model**	***TBL* Model**	***QBL* Model**	***E&S* Model**	***TBL* Model**	***QBL* Model**
Economic	*Ln(CCRP)*	1.308 *** (0.405)	0.942 * (0.523)	0.853 ** (0.423)	1.727 *** (0.206)	1.551 *** (0.328)	1.655 *** (0.242)
	Ln(BPRP)	0.213 *** (0.029)	0.243 *** (0.025)	0.244 *** (0.023)	0.123 *** (0.015)	0.102 *** (0.015)	0.162 *** (0.023)
	Ln(RENTs)	0.381 *** (0.082)	0.207 * (0.133)	0.224 ** (0.092)	0.440 *** (0.090)	0.238 ** (0.102)	0.268 *** (0.091)
	RIR	−0.003 (0.025)	−0.009 (0.022)	−0.007 (0.020)	0.001 (0.012)	−0.004 (0.030)	−0.005 (0.005)
	UNEMP	−0.015 ** (0.007)	−0.021 ** (0.009)	−0.023 *** (0.008)	−0.009 ** (0.004)	−0.010 ** (0.005)	−0.001 (0.005)
Social	*GINI*	−0.020 * (0.014)	−0.003 (0.015)	0.001 (0.010)	−0.028 *** (0.009)	−0.016 (0.013)	−0.016 *** (0.005)
	Ln(PPDnst)	0.718 * (0.372)	1.785 *** (0.443)	1.998 *** (0.359)	1.220 *** (0.175)	0.816 *** (0.300)	0.894 *** (0.216)
	Ln(HSGCost)	0.546 *** (0.194)	0.516 *** (0.121)	0.552 *** (0.140)	0.468 *** (0.133)	0.325 *** (0.124)	0.319 ** (0.152)
	Ln(HSGDep)	−0.027 (0.024)	−0.065 *** (0.020)	−0.040 * (0.025)	0.100 *** (0.036)	0.094 * (0.051)	0.007 (0.026)
Environmental	*Ln(EngRes)*		0.287 *** (0.086)	0.268 *** (0.064)		−0.108 (0.270)	−0.179 (0.197)
	Ln(Waste)		−0.112 * (0.063)	−0.134 ** (0.065)		0.234 (0.235)	0.102 (0.085)
	D(LivEnv)		−0.010 (0.008)	−0.005 (0.008)		−0.002 (0.012)	−0.001 (0.007)
Institutional	*D(TrCost)*			−0.016 (0.011)			−0.003 (0.012)
	WGI			0.159 * (0.089)			−0.081 (0.097)
Constant C		−8.410 *** (2.201)	−12.558 *** (2.488)	−13.380 *** (2.353)	−12.374 *** (1.416)	−9.259 *** (3.440)	−9.162 *** (2.707)
Cross fixed effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		183	168	168	179	164	165
Adj. R-squared		0.859	0.870	0.880	0.744	0.830	0.849
F-statistics		41.843 ***	38.661 ***	35.795 ***	41.315 ***	32.154 ***	43.373 ***

Notes: *E&S* Model—environmental and social model; *TBL* Model—triple bottom line model; *QBL*—quadruple bottom line. Heteroskedasticity robust standard errors are presented in parentheses and the statistical significance of the coefficients is interpreted as: *** p-value < 0.01, ** p-value < 0.05 and * p-value < 0.1.

Studying the results of regressions, we notice that their parameters are quite close in statistical significance and size to those resulting from the analysis of the effects of sustainability on housing price dynamics in the whole population, which confirms the robustness of the results. The economic and social dimension of sustainability is mostly influenced by changes in residential property prices in both groups of states, as the two dimensions also capture the foundations of the real estate market. However, in a more in-depth analysis of the results, we note some differences in terms of intensity and statistical significance of the effects of variables on changes in house prices.

In the group of countries with a lower degree of involvement in sustainable development, the positive change in costs of materials and labor required for the construction of residential buildings has a greater influence on rising house prices than in the group of countries with superior performance in sustainability, according to the size and strong statistical significance of the *CCRP* variable coefficients (in all three models, β_1 varies between 1.551 *** and 1.727 ***). The burden of higher real construction costs is transferred by developers to buyers, thus leading to an appreciation of construction financing costs and, consequently, to a decrease in the new housing stock and an increase in house prices. Finally, increased housing prices make it difficult for low- and middle-income people to access decent housing. In contrast, the building permit variable (*BPRP*) puts more pressure on price increases in countries with higher performance in meeting the SDGs (β_1 varies between 0.213 *** and 0.244 ***) than in other states (β_1 fluctuates between 0.102 *** and 0.162 ***). The upward trend in house prices under the influence of rising supply, expressed by the costs and permits to build residential buildings (*BPRP*), is a signal of the active development of the housing construction industry, which reacts to the high demand for housing (the need for more homes). According to Fransen et al. [93], the minimum investment required for Europe to build and renovate the housing stock, which meets the conditions for adequacy, energy efficiency and affordability, is EUR 57 billion per year. As demand continues to rise, most EU citizens find it much harder to find affordable housing in the European capitals than in other cities. Among the least accessible urban real estate markets are Paris, Stockholm, Helsinki, Amsterdam, Copenhagen, Luxembourg, Berlin, London and Dublin [94], the capital cities of the countries with the greatest progress in terms of sustainability. The high demand pressure on housing prices in the group of leading states in sustainability is also highlighted by the high positive values of the coefficients of the population density variable (*PPDnst*), the influence being 1.8–2%, unlike the second group, where the elasticity housing prices depending on demand is equal to 0.9–1.2%. Meeting the need for more affordable housing guarantees the population significant benefits for health, social and economic well-being and, at the same time, contributes to the achievement of target 11.1 of SDG 11 on ensuring access to adequate, affordable and accessible housing for all by 2030.

In the states with lower performance in reaching the 17 SDGs, the negative relationship between the inequality of income distribution reported by *GINI* and house prices is more obvious, given the size and statistical significance of the coefficients in the E&S models ($\beta_2 = -0.028$ ***) and QBL ($\beta_2 = -0.016$ ***). Thus, in the case of these countries, which are characterized by a higher degree of inequality, and their average of *GINI* being equal to 32, the increase in income inequality has a significant negative impact of 1.6–2.8% on residential property prices. The indirect relationship between house prices and income inequality characteristics of the group of countries with low results in sustainable development can be explained by the predominance of low-income households that generally opt more for poorer quality housing, as opposed to high-income households that bid more for high-quality housing [65]. Therefore, the slope of the equilibrium price of housing is determined by the willingness of households to pay for the difference in quality. The lack of statistical significance of *GINI* coefficients in the sample of performing states in terms of sustainability is also supported by other studies, such as Hassani et al. [95], which shows that increasing income inequality is not important information for forecasting house price trends in the UK.

Consistency in intensity and statistical significance shows the direct relationship between house prices and housing maintenance costs (*HSGCost*) in the group of countries with higher results in sustainable development. An increase of 1% in the share of costs necessary to maintain housing in the disposable income of the population would contribute to an increase by 0.5–0.6% in house prices, which inevitably results in house price inflation. According to Eurostat data, in the first group of countries, costs associated with housing accounted for 24% of total household expenditure and 20% of total disposable income in 2018, as opposed to the second group, where costs are slightly lower and 20% of total expenditure and 19% of disposable income.

Contradictory is the influence of the variable deprivation of adequate housing (*HSGDep*) on real housing prices in the two groups of countries. In countries with stronger commitments to sustainable development, the influence is negative and statistically significant only in the TBL model ($\beta_2 = -0.065$ ***), whereas in countries less involved in sustainable policies, the influence is positive and significant in the E&S model ($\beta_2 = 0.100$ ***). Therefore, the increase in the share of the private population in adequate housing in the total household population is reflected in a fall in house prices in the EU's leading countries in sustainability, most likely explained by a decline in the purchasing power of demand, and the rising house prices in lower-performing countries, which widen the gap between rich and poor.

The variables related to the environmental dimension of sustainability mostly differentiate the reactions of house prices to sustainability factors in the two groups of states. In countries with higher performance in SDG implementation, there is a statistically significant direct relationship between real house prices and energy consumed by households (*EngRes*) ($\beta_3 = 0.287$ *** and $\beta_2 = 0.268$ ***), as opposed to the indirect but statistically insignificant relationship ($\beta_3 = -0.100$ and $\beta_3 = -0.179$) specific to the group of states with lower results in SDG implementation. Although household energy efficiency has improved by 28% in the EU since 2000 due to more efficient heating systems, buildings and renovations [96], the effects of these efficiencies are not yet visible in all residential real estate markets in the form of green premiums, whereas the European Commission's 2020 estimates show that around 75% of the EU's stock of buildings is energy inefficient. Leading countries in developing sustainability are characterized by: more spacious housing, with average areas of 93.2 m^2, higher than the average of the second group of countries of 87.8 m^2, equipped with an average of 1.7 rooms/person, compared to 1.4 rooms/per-son in the other group; old buildings, almost half of the residential buildings being built before the introduction of the first thermal regulations (built before 1970); the fact that on average 66% of the population lives in detached and semi-detached houses, as opposed to 54% in the second group's population, with these dwellings requiring higher energy consumption for heating and cooling the air [97]. These results justify the significant direct relationship between house prices and energy consumption in these countries.

The negative influence of waste from construction, demolition, repair and arrangement of housing per capita (*Waste*) on housing prices is valid only in the group of states more strongly committed to achieving the 17 SDGs, especially in the QBL model, where the coefficient $\beta_3 = -0.134$ is statistically significant, being in conformity with the results of other studies [98]. Therefore, a 1% increase in the amount of waste, which contributes to landfilling, has the effect of lowering house prices by 0.13% in higher-performing countries in terms of sustainability. Thus, the housing market perceives the negative externality caused by construction waste by reducing the value of buildings in its vicinity. In the group of states with weaker results in sustainable development, the reaction of house prices to the change in the amount of waste is lacking, with the coefficients of the waste variable not fulfilling the condition of statistical significance.

According to the estimated results, in none of the analyzed samples do the variables *TrCost* and *WGI*, characteristic of the institutional dimension, statistically significantly contribute to the real change in house prices, proving, in fact, that the other dimensions of sustainability have a greater direct predictive capacity on the change direction of the

residential real estate market. However, maintaining transaction costs at a justified market level and the sound management of public institutions remain indispensable conditions for the efficient and transparent functioning of the real estate market.

4.3. Robustness Testing

To test the robustness of the results, we studied the relationship between the variables of each dimension of sustainability and real house prices, at the level of the entire sample of EU-28 countries, using the 2SLS method, with cross-section fixed effects, by alternatively instrumenting all regressors for each of the sustainability dimensions with their own lags. Table 4 shows results similar to those in Tables 2 and 3, in that the sign, direction of influence and level of statistical significance remain largely the same.

Table 4. Relationships between house prices and the individual dimensions of sustainability.

Dependent Variable—*Ln(HPI)*					
Variables		**Economic**	**Social**	**Environmental**	**Institutional**
Economic	*Ln(CCRP)*	1.488 *** (0.077)			
	Ln(BPRP)	0.176 *** (0.011)			
	Ln(RENTs)	0.485 *** (0.026)			
	RIR	0.004 (0.006)			
	UNEMP	−0.008 *** (0.003)			
Social	*GINI*		−0.022 ** (0.011)		
	Ln(PPDnst)		0.560 ** (0.233)		
	Ln(HSGCost)		0.536 *** (0.130)		
	Ln(HSGDep)		0.119 *** (0.010)		
Environmental	*Ln(EngRes)*			0.016 (0.352)	
	Ln(Waste)			0.336 *** (0.090)	
	D(LivEnv)			−0.034 *** (0.014)	
Institutional	*D(TrCost)*				0.078 *** (0.014)
	WGI				−0.197 (0.470)
Constant C		−5.358 *** (0.428)	2.777 *** (1.074)	2.521 (2.165)	4.680 *** (0.526)
Cross fixed effects		Yes	Yes	Yes	Yes
Observations		455	368	339	453
Adj. R-squared		0.879	0.394	0.153	0.329
F-statistics		65.081 ***	8.408 ***	8.951 ***	11.425 ***

Notes: Heteroskedasticity robust standard errors are presented in parentheses and the statistical significance of the coefficients is interpreted as: *** *p*-value < 0.01 and ** *p*-value < 0.05.

The economic and social attributes of sustainability remain the most representative in relation to house prices, consolidating the idea of price formation based on the fundamentals of the residential real estate market. All variables of an economic and social nature, with the exception of the interest rate, registered statistically significant coefficients and signs in line with the results of other specialized studies [54,59,64,67]. This allows us to re-iterate the validation of the second hypothesis regarding the significant link between the dynamics of residential property prices and the economic and social dimensions of sustainability.

Testing the robustness of the results shows that environmental information is only partially captured by the market, given that only the variables that describe the amount of generated waste (*Waste*) and living environment (*LivEnv*) are reflected in housing prices. The positive sign of the waste variable became statistically significant following the robustness test, which can be explained by the reaction of the construction sector to the growing demand for housing. Given that 75% of the existing building stock in the EU is still energy inefficient, despite progress in recent years, the housing market still does not fully recognize the effect of increasing energy efficiency in order to capitalize it in real estate prices in the form of green premiums. These considerations lead us to only partially validate the third hypothesis on the relationship between the variation of housing prices and the environmental dimension of sustainability, along with the other two dimensions—economic and social.

Regarding the institutional dimension of sustainability, we note the improvement of the statistical significance of the positive influence of transaction costs (*TrCost*) on house prices and the maintenance of the insignificance of governance efficiency (*WGI*). This empirical evidence shows that higher trading costs amplify house prices, and the efficient governance has the effect of making real estate market mechanisms more transparent in order to align prices to market fundamentals. Based on these explanations, we appreciate that the forth hypothesis is partially validated by the estimated results.

5. Conclusions

Over the last ten years, the issue of building stock sustainability has been high on the European agenda, and is now one of the EU's priorities for "smart, sustainable and inclusive growth" and a coherent element of EU climate and energy policy [27] (p. 78).

Our paper aims to examine the extent to which, at the EU-28 level, in the period 2000–2018, the four dimensions of sustainable development, also known as the quadruple bottom line (QBL)—the economic, social, environmental (these three being included in the triple bottom line (TBL) approach) and institutional dimensions—play a significant role (or not) in shaping the prices of residential real estate. In this sense, the research was carried out in two stages.

In the first stage, testing the impact of sustainability attributes on prices in all real estate markets of the EU-28, we see the prevalence of significant links between housing price dynamics and economic and social dimensions, but also much lower capitalization of environmental variables and the non-existence of such a capitalization, in the case of the institutional dimension. In general, the obtained results confirm the expected associations, according to the literature and authors' expectations. It is found that, in most cases, the successive introduction of the environmental and institutional dimensions, together with the economic and social (E&S) dimensions, in order to reflect the TBL and QBL visions, does not alter the meaning and statistical significance of the links. The results prove the complexity of the connection between the evolution of house prices and the attributes of sustainability, with the composition of price determinants invariably depending on the economic and social component and to a very small extent on the environmental and institutional dimensions.

Therefore, despite the progress made, the results of our study show that there are still important steps to be taken by the real estate industry in the field of sustainable development, which must take into account not only profit and people, but also the planet and purpose. Environmental aspects seem to be rather neglected by real estate market

players, and its transparency and efficiency leave much to be desired, in the context of the existence in some EU-28 member countries of problems of efficient management of the institutional framework in which these actors operate.

The results must be interpreted in the context of the significant heterogeneity of the national real estate markets that make up the EU-28 market. For this reason, our investigation deepens the analysis by moving to the second stage of research. This involved splitting into two groups of member countries, depending on the degree of SDG implementation: countries strongly involved in SDG implementation and countries with a lower involvement in this field. The results of this second stage highlight, once again, the greater sensitivity of prices to the attributes of the economic and social dimensions of sustainability, with some nuances related to different intensities and statistical meanings between the two groups of countries. For example, in countries more involved in sustainable development, there is greater pressure on real estate prices due to the dynamics of the number of building permits issued (*BPRP*) and population density (*PPDnst*), which significantly increase market demand. On the other hand (in the countries with lower scores of the SDG Index), a stronger influence than in the case of the previous group is found in terms of the dynamics of real construction costs (*CCRP*) and inequality of income distribution (*GINI*). Additionally, the economic variable of unemployment rate (*UNEMP*) has a more intense impact and statistical significance as we move from one model to another in the group of countries more committed to sustainable development than in the other group, where the addition of the institutional dimension leads to the statistical significance of the indicator. A similar evolution can be seen in the social variable of deprivation of housing (*HSGDep*), which has a more pronounced influence on the E&S model in the second group of countries, but loses its statistical significance by adding environmental and institutional dimensions. These seemingly contradictory results can be explained by the fact that in the two groups of countries, there are both states with strong economies and less economically developed countries, noting that some developed economies, such as Italy or Spain, are included among the weaker performers in terms of sustainability, while less traditional market economies such as the Czech Republic, Slovenia or Estonia have taken important steps towards sustainable development, achieving higher SDG scores.

The most important differences between the two groups of countries are in terms of environmental and institutional attributes of sustainability. Factors such as energy consumption (*EngRes*), the amount of construction waste (*Waste*) and governance efficiency (*WGI*) are among the determinants of residential property prices in countries with greater involvement in sustainable development, but do not exert any influence on prices in the case of the other group. Therefore, the advance taken by some states in the line of SDG implementation is also felt in the real estate market.

The results of this research may guide real estate developers and investors in substantiating development strategies appropriate to the classes of receptive customers and those willing to pay for housing that meets sustainability standards. Knowing the dimensions of sustainability with a significant influence on price allows real estate developers and investors to anticipate the structure of future costs determined by the implementation of attributes associated with sustainability in real estate projects and estimate the amount of capital invested. Developers and investors have the opportunity to become proactive in proposing solutions for regulating the sustainability of the built environment, based on knowledge of the extent to which the attributes of sustainability are capitalized in price on the real estate market. Given the importance of sustainability dimensions in price formation in residential markets, real estate appraisers must acquire the ability to incorporate the sustainability attributes of buildings into real estate valuation methods, especially discount rates.

The results of the paper should be interpreted in the context of the limitations inherent in any research. Thus, data aggregation always involves the loss of information. In addition, this research was carried out on a larger spatial scale, which does not allow capturing the nuances of local markets, in terms of the size of sustainability, which can determine

the prices of residential properties. Further studies may extend this analysis to local market characteristics.

Author Contributions: Conceptualization, M.M. and E.I.; methodology, E.I.; software, E.I.; validation, M.M., E.I., M.C.H. and A.Ț.; formal analysis, M.M.; investigation, M.M., E.I., M.C.H. and A.Ț.; resources, M.M. and E.I.; data curation, E.I.; writing—original draft preparation, M.M. and E.I.; writing—review and editing, M.M., E.I., M.C.H. and A.Ț.; visualization, M.M. and M.C.H.; supervision, M.M., E.I., M.C.H. and A.Ț. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Descriptive statistics.

	Variables	Observations	Mean	Std. Dev.	Min.	Max.
Dependent	*HPI*	495	101.88	22.21	43.07	211.68
Economic	*CCRP*	529	99.89	7.09	73.55	133.10
	BPRP	514	220.94	331.87	19.30	3184.00
	RENTs	530	86.53	17.56	21.35	124.16
	RIR	532	1.84	3.86	−45.70	10.32
	UNEMP	530	8.44	4.37	1.70	27.30
Social	*GINI*	512	29.69	4.00	20.90	40.20
	PPDnst	532	173.49	242.39	16.99	1511.03
	HSGCost	398	20.57	6.03	6.90	42.50
	HSGDep	403	8.60	8.92	0.30	41.70
Environmental	*EngRes*	532	591.72	207.93	156.00	1165.00
	Waste	386	403.47	116.25	42.00	1099.00
	LivEnv	404	15.17	6.82	4.00	41.40
Institutional	WGI	532	1.07	0.50	−0.18	1.97
	TrCost	530	1.96	1.55	0.00	9.03

Source: Authors' processing.

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