Interest rates and real estate dynamics: an analysis of property prices in advanced economies

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Abstract

Title: Interest rates and real estate dynamics: an analysis of property prices in advanced economies

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This thesis investigates the relationship between government bond yields and residential property prices across several advanced economies. The study was carried out using different panel specifications to examine how this relationship changes when accounting for unobserved country-specific and time-specific factors. The significant negative correlation established through OLS and country fixed effects regressions is consistent with traditional economic theory, suggesting that higher bond yields (which usually lead to higher mortgage rates) dampen demand for housing and decrease property prices. However, when accounting for only time-fixed effects, the model indicates a significant positive relationship, implying that when global trends are absorbed, other factors specific to each country may drive this outcome. Lastly, the two-way fixed effects regression shows a negative but non-significant association. Controlling for both country-specific and time-specific effects, the model absorbs much of the variability that can explain the relationship, leading to a weaker and statistically insignificant association. The results reveal a complex relationship between government bond yields and real estate prices. Through the analysis of this connection across multiple countries, this study addresses the literature's gaps and provides insights to policymakers, investors, homeowners and the real estate industry.

Keywords: Government Bond Yields, Real Estate, Fixed Effects, Interest Rates, Property Prices, panel study.

Resumo

Título: Taxas de juros e dinâmicas do mercado imobiliário: uma análise dos preços de propriedades em economias desenvolvidas.

Autor: Alessandro Benincasa

O propósito desta tese baseia-se na investigação da relação entre os rendimentos das obrigações do tesouro e os preços da habitação em várias economias desenvolvidas. O estudo foi realizado utilizando diferentes especificações de painel para examinar como esta relação se altera quando se contabilizam fatores específicos de cada país e de cada período. A correlação negativa significativa, estabelecida através de regressões OLS e efeitos fixos por país, é consistente com a teoria económica tradicional, sugerindo que rendimentos mais altos de obrigações (que normalmente conduzem a taxas de juro hipotecárias mais altas) reduzem a procura por habitação e, por consequência, diminuem os preços das propriedades. No entanto, ao considerar apenas os efeitos fixos no tempo, o modelo indica uma relação positiva significativa, sugerindo que, quando as tendências globais são absorvidas, outros fatores específicos de cada país podem influenciar este resultado. Por fim, a regressão de efeitos fixos bidirecionais demonstra uma associação negativa, mas não significativa. Ao controlar tanto para os efeitos específicos de cada país, como para os efeitos temporais, o modelo absorve grande parte da variabilidade que pode explicar a relação, levando a uma associação mais fraca e estatisticamente insignificante. Os resultados revelam uma relação complexa entre os rendimentos de obrigações do tesouro e os preços imobiliários. Através da análise desta conexão em vários países, este estudo aborda as lacunas da literatura e oferece *insights* para responsáveis políticos, investidores, proprietários e a indústria imobiliária no geral.

Palavras-chave: Rendimentos de Títulos Públicos, Imóveis, Efeitos Fixos, Taxas de Juros, Preços de Propriedades, estudo em painel.

Contents

1. INTRODUCTION

1.1 Background

The real estate market is a complex and dynamic industry. Its intricacies are entwined with a multitude of variables, one of which stands out as pivotal and has a substantial impact on property prices: interest rates (Solá, 2023). The aim of this study is to test whether there is a significant relationship between government bond yields and real estate prices. For this purpose, various panel regression specifications have been employed, including a linear panel (OLS), a panel regression with country-fixed effects (FE), a panel regression with time FE, and a panel regression that includes both country and time FE. This research focuses on two groups: the first includes 20 countries globally, and the second includes 12 member countries of the European Economic Area (EEA), which are vested in the first group. Including a sample with only EEA countries has the advantage of focusing on a more uniform economic and regulatory environment, allowing to isolate more clearly the impact of different regional policies and economic conditions. This homogeneity reduces variability and allows a more precise analysis of the connection between government bond yields and house prices.

Interest rates are driven by many factors, such as global economic conditions (e.g. housing booms, crashes), inflation rates, government and central bank policies, and economic trends. Fluctuations in these variables have a considerable effect on the real estate sector (Yiu, 2021). Therefore, a critical analysis of the real estate industry and interest rates is needed to understand how these two factors relate to each other.

The objective of this paper is to examine factors that drive the correlation between government bonds and house prices at the global and European level. It seeks to understand how this relationship changes when unobserved country- and time- specific factors are taken into account. The considered scope, which includes the examination of this relationship across several countries, contributes to filling the gaps in the existing literature. Real estate experts, investors, legislators, homeowners, and other negotiators can use the findings of this research to improve their understanding of the market and their decision-making.

1.2 Problem Statement and importance of the study

Interest rates impact housing affordability and the attractiveness of real estate investments, as well as the overall condition of the housing market (Korevaar, 2023). Consequently, comprehending how yields on government bonds affect real estate prices holds significant

relevance for decision-makers in politics, finance, real estate, and homeownership.

Additionally, when it comes to studying whether changes in real estate prices are associated with interest rate changes, existing research frequently focuses on a specific region or country. Hence, the focus of the research is to conduct panel- study analyses that will investigate the correlation between these two variables within and across different countries. Finding patterns and market trends that might go unnoticed when looking at the real estate market in a single region is one of the goals of this methodology.

1.3 Structure of the thesis

There are 6 main components to the research. The introduction makes clear the issue and background information for the study as well as its goals and importance. The literature review presents a theoretical analysis of the link between government bonds and property prices and offers claims and supporting data from previously published works. The third and fourth parts outline the various approaches used in the data collecting and methodology processes. The investigations' findings are presented in the fifth section, while the last part includes the conclusion along with a brief discussion of the limitations and recommendations.

2. LITERATURE REVIEW

2.1 Impact of Government Bond Yields on Property Prices

To comprehend the dynamics of the housing market, investigating the methods by which shifts in bond rates may affect real estate prices is necessary. Frequently regarded as a proxy for interest rates, government bond yields are strictly related to borrowing costs and, therefore, have a substantial impact on the real estate market (Forsyth, 2023).

Often, an increase the bond yields is associated with a higher borrowing rate for the whole economy (Ramchander et al., 2003). This increase in interest rates leads, in turn, to more expensive mortgages, discouraging potential buyers and investors. The reduced affordability decreases the demand for housing, potentially leading to a slowdown in the real estate industry. On the contrary, lower interest rates have a positive impact on the real estate market, leading to higher property prices. According to economic theory, investments and borrowing are stimulated by low rates. Hence, the real estate industry can thrive under such circumstances. Most of the model specifications employed in this study will confirm this theory.

Investor behaviour is another influential factor connected to property prices and yields on government bonds. Real estate and bonds are often observed as rival investments (Vonlanthen, 2023). In periods when bonds are outperforming, investors may be inclined towards investing in fixed-income instruments, also due to their higher perceived safety. In this scenario, potential investments meant for real estate may get diverted, affecting property prices. On the other hand, during periods of low interest rates, real estate is likely to be more attractive to investors, given its potential to generate higher returns. The outcome of the relationship between returns on government bonds and real estate markets is highly diverse and dynamic across the globe (Bloomberg, 2023). Other driving forces in this landscape are location, economic conditions, and market factors. For instance, Cicmil (2023) analyzed the correlation between macroeconomic factors, specifically interest rates and inflation, and the performance of real estate indices in the United States and the European Union. The impact of interest rates on real estate indices negative in Europe but not in the US, confirming the significant role played by different economic and financial conditions.

Furthermore, according to Block (2011), REITs (Real Estate Investment Trusts) are also related to interest rates, and therefore, changes in sovereign bonds have an impact on them. Case studies on REIT have enhanced the significance of comprehending the relationship

between real estate investments and bond yields. When interest rates are high, investors are likely to search for opportunities that project the ability to maximize returns. Consequently, REITs with low returns may encounter challenges that affect the value of these assets with a high real estate concentration.

Lemmon and Portniaguina (2006) stated that market trends and consumer confidence are affected by returns on government bonds. The rise in interest rates can be either a sign of prosperous economic conditions or inflation worries. To control this scenario, central banks play a vital role by modifying monetary policies and increasing interest rates. However, a high- interest rate is a source of discouragement for potential buyers as the market becomes less affordable. Conversely, declining bond yields indicate a need to improve economic activity and could be responsible for positively influencing consumer behaviour and promoting the real estate industry (Crockett, 1996).

Lastly, building and development expenses related to real estate are also impacted by bond rates. When interest rates increase and development expenditures become more expensive due to financing costs, the availability of new dwellings is minimized, causing an imbalance between supply and demand (Porter, 2023). As a result, the real estate market is likely to slow down if development costs are too high. The opposite happens with decreasing interest rates and lower building and development expenses.

The following Figure 1 represents the Case-Shiller Home Price Index, which is a leading measure for evaluating and estimating US residential real estate prices. This index helps to calculate the repeat-sale house price index that tracks changes in the value of residential real estate both nationally and across the US metropolitan regions. Similarly, it shows the historical change in prices across the US residential housing over time. The figure covers a long period from 1880 to 2020. It can be noticed that the US residential housing prices remained relatively stable or showed low volatility until the late 1990s. After that, there was a rapid increase in home prices, indicating the steep upward trend that characterized the housing bubble of the mid-2000s. After the bubble burst in 2007, home prices gradually recovered. Hence, Figure 1 provides a historical perspective on the cyclical nature of the real estate market.

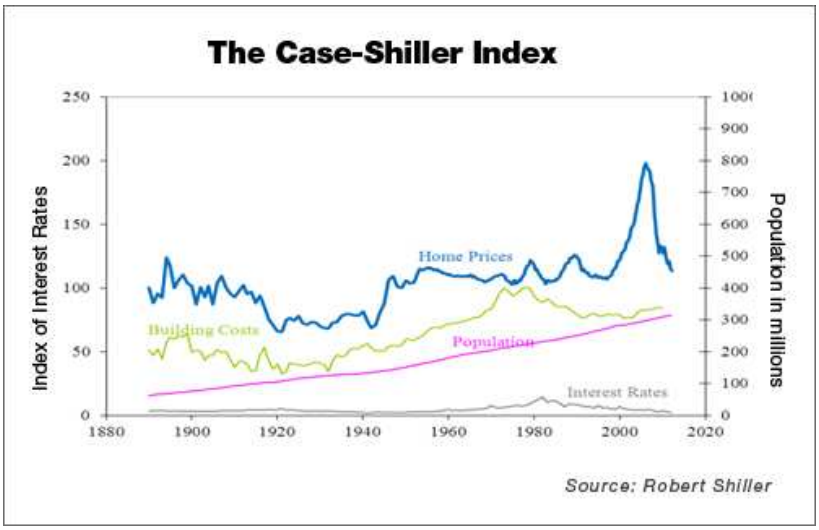

Figure 1: The Case-Shiller Index

(Source: Robert Shiller as cited in Moneylife Advisory, 2012)

2.2 Theoretical Background and Prior Empirical Studies.

While most empirical studies found that monetary policy has a significant effect on house prices (Berlemann and Freese, 2012), some scholars believe that it is difficult for interest rates to have a long-term impact on real estate prices due to the influence of other economic factors (Chen at. al., 2022). These contrasting results highlight the complexity of the relationship between monetary policy and housing markets, underscoring the need to conduct comprehensive research to learn more about the link between these variables.

The paper by Shi, Jou, and Tripe (2014) observes the impact of retail mortgage rates and central bank policy on original housing prices in New Zealand from 1999 to 2009. Findings from the study reveal a positive correlation between real interest rates and housing prices, opposing the expected negative relationship. The authors attributed this result to several factors, such as the short-term nature of fixed interest rates in New Zealand and the negative slope of the yield curve during the bubble period, where long-term fixed rates were cheaper than floating rates. This motivated borrowers to choose larger fixed-rate loans to minimize debt servicing costs and exposure to future rate increases. Despite the subsequent rise of fixed rates, borrowers continued to take on debt, believing that property prices would continue to increase; this led to the observed positive relationship. Hence, the authors put the interest rates' effectiveness in controlling these housing prices to query, leading to a commendation for alternative measures like macroprudential tools. However, the findings of this study are limited by the relatively short period tested and by the sole focus on the New Zealand market.

Even though the main result of this paper mostly differs from the findings obtained in this study, the authors also found a negative relationship between changes in the unemployment rate and changes in property prices. This result aligns with most of the findings obtained by the model employed in this research, especially when considering only European countries or when country-fixed effects are included.

Meanwhile, the study conducted by Vonlanthen (2023) examined the relationship between interest rates and real estate prices in Switzerland for the specific timeline of 2005 to 2018. Analyzing six real estate segments across 106 regions, the study measures the impact of four interest rate proxies, including yields built up on government bonds and mortgage rates. The researchers employed a fixed-effect panel regression model, revealing varying effects across real estate types and Swiss regions. Residential housing prices, particularly for houses and owner-occupied flats, show a significant negative relationship with variable and fixed mortgage rates. Urban areas were found to exhibit higher interest rate sensitivity in residential housing, highlighting interest rate effects' segment-specific nature. Both the methodology used and the results obtained in the research are similar to the ones of this study, however, while the paper only focuses on one state (Switzerland), this study analyzes the relationship across multiple countries. Vonlanthen also found a negative relationship between population growth and residential prices, a controversial result that is also observed in this study when employing the panel regression model with country-fixed effects. The author suggested that this could be explained by the fact that property prices are influenced more by population density than by the overall population growth.

Another fixed-effect panel regression model was implemented in the study conducted by Belke and Keil (2018). As in this research, the authors started by implementing an Ordinary Least Squared regression without fixed effects, then added a specification with only country-fixed effects, and then added both country and time-fixed effects in the final model. The objective of this research was to evaluate fundamental determinants of real estate prices. The dataset comprised apartment and house prices in 127 German regions, as well as yields on 10-year government bonds, with data from 1990 to 2010. The authors found a positive relationship between real estate prices and government bonds across all models. According to their findings, a 1% rise in interest rates results in an approximately 4% increase in housing prices, with small differences across the different model specifications. The researchers explain this unexpected result by asserting that in this setting, interest rates do not capture increasing financial costs but instead mirror the economic landscape and cyclical position of

the economy. The latter, in turn, influences the housing demand. Belke and Keil also found a negative relationship between the unemployment rate and housing prices in almost all their model specifications.

Drechsler, Savov and Schnabl (2021) investigated the impact of monetary policy on the housing boom between 2003 and 2006. The authors explored the "deposits channel," which suggests that when the Federal Reserve raises interest rates, banks' deposit funding costs increase, leading them to reduce portfolio mortgage lending. However, this reduction was offset by an increase in privately securitized (PLS) mortgages, particularly by nonbank entities. The study used administrative data from the Home Mortgage Disclosure Act (HMDA) and other sources to analyse loan-level information on residential mortgages. The study finds significant variation in the sensitivity of mortgage lending to monetary policy across different counties in the US, with some clustering in the Northeast. Countries with higher sensitivity to monetary policy (high betas) experienced a shift from bank portfolio lending to PLS lending, with nonbanks playing a significant role in this shift. These findings provide an interesting framework for understanding how mortgage lending may vary across regions, influenced by their differing sensitivities to monetary policy.

Chen et al. (2022) focused on the dynamic link between interest rate changes and real estate market transactions in China, with vital consideration of the role of government macro-controlled interest rates in the real estate market. The aim was to investigate the influence of interest rates on housing prices by employing experimental economics to mimic real estate transactions in the actual market. Unlike previous macro-data-centric studies, this approach allows a controlled examination of interest rate effects, minimizing the influence of economic disparities and geographic variations. In line with the literature, the findings indicate that high lending rates limit the buyers' willingness to buy houses, leading to lower property prices. The study emphasized interest rate policies have a nuance influence on diverse real estate market dynamic aspects and suggested that high interest rates contribute to regulating housing prices, thereby providing important insights for government interventions in the Chinese real estate sector.

Berlemann and Freese (2012) also investigated the implication of monetary policies on various segments of the real estate sector in Switzerland. The primary objective that was identified was to investigate central banks effectivity in using policy instruments to stabilize asset prices. The researchers employed a vector autoregressive model, analyzing the responses of stock markets with additional different sub-segments of the real estate market

to interest rate shocks. The results portrayed that while monetary policy did not significantly impact stock markets, it influenced the aggregate real estate market. Moreover, the study showed varying responses in house and apartment prices, along with rental prices, highlighting the distinct reactions within the private real estate market.

Overall, while the empirical studies reviewed above offer interesting insights into the relationship between interest rates and property prices, some suggest a significant negative correlation while others highlight more varied effects. The findings underscore the importance of conducting research in this field, and this study, by analyzing the relationship on a broader level across multiple countries, can contribute to the literature.

3. DATA

A systematic data collection approach has been employed to come up with appropriate data for this research. The analysis entails consideration of respective interest rates, property prices and control variables for 20 countries. Regarding interest rates, as advised in the research conducted by Vonlanthen (2023), the 10- year government bond yield has been selected instead of the central bank policy rates. This choice is made considering that the latter represents short-term interest rates. Given the long-term nature of real estate assets, a broader time frame is considered more appropriate for this analysis. The 10-year government bond yields for each country have been retrieved from Federal Reserve Economic Data (FRED) with a quarterly frequency.

The performance of the real estate market has been gauged using the long series on nominal residential property prices developed by the Bank for International Settlements (BIS). These series contain quarterly data covering all types of residential properties in markets for both new and existing dwellings in the country as a whole. They were made to harmonize and facilitate the comparability of house price indices across countries by normalizing the data to a base value of 100 in the year 1995 (Bank for International Settlements, 2024). However, being constructed from a variety of sources, they are still imperfect. A detailed description of each country's series with the respective source can be found in Appendix I. Hong Kong, Malaysia and Thailand have been excluded from the analysis due to data unavailability. The data sample contains quarterly data from 1991:Q1 to 2017:Q4. However, for analyses that include control variables, the time frame varies according to the data availability of the respective variables.

GDP by expenditure, unemployment rates, and population growth have been selected as control variables. Data for GDP and population growth are represented by quarterly indices (year 2000=100), while the unemployment rates are expressed in percentage points. Both unemployment rates and population growth contain data on people aged between 15 and 64 years old. A negative correlation is anticipated between unemployment rates and real estate prices since real estate demand is lower in countries with higher unemployment rates (Agnew and Lyons, 2018). Conversely, a positive relationship is expected between property prices and both population growth and GDP, as an increase in these variables typically leads to a higher demand for real estate prices. All data about the control variables have been retrieved from the Federal Reserve Economic Data (FRED). Table 1 describes the variables used in

this study, Table 2 shows descriptive statistics including all 20 economies worldwide and Table 3 shows the descriptive statistics when accounting only for members of the European Economic Area (EEA):

Table 1: Variables description

Variable name Description	Source
Prices	
Long historical time series on nominal residential property prices. Quarterly indeces (1995=100)	Bank of International Settlement
Bonds (10y)	
Yields on governmental with 10-year maturity. Quarterly data	Federal Reserve Bank
GDP	
Gross Domestic Product by expenditure. Quarterly indeces (2000=100)	Federal Reserve Bank
Population	
Working age population growth (15-64 years old). Quarterly indeces (2000=100)	Federal Reserve Bank
Unemployment	
Unemployment rate: age 15-64. Quarterly data (%)	Federal Reserve Bank

Note: All date source from Bank of International Settlement and Federal Reserve Bank; variables include indexed and percentage values for economic indicators.

Table 2: Descriptive statistics – 20 economies worldwide

Variable name	Min	Max	Mean	Median	SD	Obs
Nominal residential property prices. Quarterly indeces (1995=100)	60.71	861.67	189.62	155.20	114.78	2200
Yields governmental bonds (10Y) (%)	-0.51	17.05	4.83	4.45	2.97	2162
Gross Domestic Product by expenditure. Quarterly indeces (2000=100)	-328.18	542.48	96.53	97.12	73.97	2094
Working age population growth. Quarterly indeces (2000=100)	-4567.48	3210.52	107.36	101.70	237.05	1722
Unemployment rate (%)	2.00	27.87	7.61	6.68	4.48	1600

Note: All the displayed values reflect descriptive statistics across 20 economies worldwide between 1991:Q1 to 2017:Q4.

Table 3: Descriptive statistics – European Economic Area

Variable name	Min	Max	Mean	Median	SD	Obs
Nominal residential property prices. Quarterly indeces (1995=100)	71.55	504.99	192.82	178.09	91.54	1320
Yields governmental bonds (10Y) (%)	-0.12	13.85	4.66	4.37	2.66	1320
Gross Domestic Product by expenditure. Quarterly indeces (2000=100)	-328.18	294.40	86.47	91.75	64.70	1226
Working age population growth. Quarterly indeces (2000=100)	-4567.48	3210.52	113.49	101.84	311.02	984
Unemployment rate (%)	2.00	26.40	8.06	7.84	3.94	875

Note: All the displayed values reflect descriptive statistics across countries members of the European Economic Area between 1991:Q1 to 2017:Q4.

3.1 Multicollinearity

To test for potential multicollinearity among the independent variables, correlation matrices have been created. Multicollinearity can undermine the reliability of regression coefficient estimates, thus compromising the interpretation of results. Typically, correlation coefficients below -0.7 or above 0.7 are considered indicative of high correlation (Alin, 2010). Table 4 displays the correlation matrix considering all 20 countries in the study, while Table 5 only focuses on the countries members of the EEA. As can be seen from the tables, the independent variables are mostly weakly correlated with each other. Hence, based on these results, all of the independent variables appear suitable for inclusion in the regression analyses conducted.

Table 4: Correlation matrix – 20 economies worldwide

	Bonds	GDP	Population	Unemployment
Bonds	1			
GDP	0.145	1		
Population	-0.042	0.066	1	
Unemployment	0.299	0.228	0.137	1

Note: All the displayed values reflect the correlation matrix showing relationships between economic indicators: Bonds, GDP, Population, and Unemployment across 20 economies worldwide.

Table 5: Correlation matrix – European Economic Area

	Bonds	GDP	Population	Unemployment
Bonds	1			
GDP	-0.244	1		
Population	-0.072	0.187	1	
Unemployment	0.024	-0.394	0.01	1

Note: All the displayed values reflect the correlation matrix showing relationships between economic indicators: Bonds, GDP, Population, and Unemployment across countries members of the European Economic Area.

4. METHODOLOGY

Four different panel specifications have been employed to test whether there is a significant relationship between yields of 10-year government bonds and real estate prices:

1. OLS: a linear panel without fixed effects proves to be beneficial as an initial step to acquire benchmark estimates (Belke and Keil, 2018):

   $$P_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 GDP_{it} + \beta_3 Unemployment_{it} + \beta_4 Population_{it} + \epsilon_{it}$$

2. Country effects: This is a one-way fixed panel regression that accounts for country-fixed effects but does not capture time-fixed effects. As mentioned by Belke and Keil (2018), analyzing real estate data in different regions can be challenging due to the heterogeneity of land property, houses, and apartments. Property prices are influenced by various factors, such as property characteristics, location, surroundings, and country infrastructure, among others. This specification is useful to address the complexity of analyzing real estate data across different countries by absorbing the fixed country effects:

   $$P_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 GDP_{it} + \beta_3 Unemployment_{it} + \beta_4 Population_{it} + \alpha_i + \epsilon_{it}$$

3. Time effects: this specification accounts for time-fixed effects without capturing country-fixed effects, thereby absorbing common time-related variation:

   $$P_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 GDP_{it} + \beta_3 Unemployment_{it} + \beta_4 Population_{it} + \gamma_t + \epsilon_{it}$$

4. Two-way effects: this specification includes time and country-fixed effects, allowing to capture both cross-sectional and time-series variations. Hence, with this regression, it's possible to analyze real estate data across different countries and over time while absorbing both the fixed country effects and the common time-related variation:

   $$P_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 GDP_{it} + \beta_3 Unemployment_{it} + \beta_4 Population_{it} + \alpha_i + \gamma_t + \epsilon_{it}$$

P_{it} represents nominal residential property prices for each country: the subscript i denotes the country and t indicates the quarter. Y_{it} specifies the 10-year government bond yield.

Control variables have been included in the model to account for other explanatory variations.

These variables are represented by the GDP growth (GDP_{it}), the unemployment rates ($Unemployment_{it}$), and the population growth ($Population_{it}$). α_i are the country fixed effects, while γ_t are the time effects for each quarter. Lastly, ϵ_{it} represents the error term.

As mentioned in the introduction, these four specifications have been applied to two different samples. The first sample includes all 20 countries in the dataset, while the second sample, a subset of the first, includes only countries that are members of the European Economic Area (EEA). Specifically, the countries belonging to the second sample are Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, the Netherlands, Norway and Sweden. Since the data sample contains quarterly data from 1991:Q1 to 2017:Q4, the United Kingdom has been included as well, as it was part of the EEA during that period.

5. EMPIRICAL RESULTS

5.1 Panel regression – 20 economies worldwide

Table 6: Regression model for 20 economies worldwide

Table 6 shows the results of the four panel specifications for the dataset that includes all 20 economies worldwide. Standard errors are in parentheses.

	Dependent variable:			
	Prices			
	OLS	*country effect*	*time effect*	*twoways effect*
	(1)	(2)	(3)	(4)
Bonds	−1,218.159***	−2,498.261***	1,383.365***	−225.884
	(90.703)	(80.315)	(150.921)	(168.550)
GDP	0.960***	0.360***	0.671***	0.347***
	(0.025)	(0.036)	(0.025)	(0.032)
Population	0.061	−0.074**	0.251***	0.007
	(0.039)	(0.030)	(0.034)	(0.026)
Unemployment	8.516***	−3.693***	4.740***	−5.953***
	(0.461)	(0.613)	(0.459)	(0.674)
Constant	97.573***			
	(6.158)			
Observations	1,562	1,562	1,562	1,562
R^2	0.588	0.512	0.613	0.157
Adjusted R^2	0.587	0.505	0.582	0.080
Note:				*p<0.1; **p<0.05; ***p<0.01

Note: Regression results with property prices as dependent variable; model includes OLS, country effect, time effect, and two-ways effect (1,562 observations) for 20 economies worldwide.

5.1.1 *OLS*

In the Ordinary Least Squared (OLS) specification, the findings indicate that, as expected, there is a significant negative relationship between residential prices and yields on government bonds, with the coefficient for 10-year government bond yields being -1218.159

and statistically significant at the 1% level ($p < 0.01$). This means that for every one-unit increase in the 10-year government bond yields, the residential prices (normalized to 1995 = 100) are estimated to decrease by 1218.159 points. As mentioned in the literature, this relationship can be justified by the higher financing costs and less appealing real estate investments related to periods with higher interest rates.

Gross Domestic Product (GDP) enters with a significant positive sign into this regression (0.960) indicating an increasing demand for houses in periods with higher GDP growth. A growing economy may lead to a positive economic sentiment, influencing people to make long-term financial commitments and boosting investors' confidence in the real estate market.

On the other hand, contrary to expectations, the unemployment rate shows a significant positive relationship with real estate prices (8.516), this result may be caused by the heterogeneity of the countries involved in this study. When controlling for country-fixed effects, in fact, this relationship appears to be negative.

Lastly, as expected, population growth presents a positive coefficient of 0.061, however, in this case, the relationship is not significant.

An adjusted R-squared of ~59% supports these findings.

5.1.2 Country Effect

When accounting for country-specific fixed effects, the coefficient for bond yields becomes even more negative (-2498.261) and remains highly significant. This implies that within each country, higher bond yields strongly correlate with lower real estate prices, reinforcing the findings from the OLS regression. By adding country-fixed effects, the model isolates the impact of bond yields on real estate prices from other time-invariant country-specific factors that might influence this relationship, comparing changes within each country over time. This more pronounced negative relationship means that, after controlling for these factors, increases in bond yields are associated with even larger decreases in real estate prices. A possible explanation for this result is that country-specific factors might have been masking the true strength of the negative relationship in the OLS specification. For instance, factors such as long-term economic policies, stable financial systems, or cultural preferences for homeownership could have a positive impact on both bond yields and property prices, diluting the observed negative effect. Hence, controlling for these factors, the model results

in an even stronger negative relationship.

Similar findings of the OLS can be observed with the gross domestic product growth, always showing a significant positive relationship, even if weaker in this instance (0.360). This means that while GDP growth is still positively associated with real estate prices, this relationship is less pronounced when controlling for country-specific effects.

On the other hand, the independent variables of population growth and unemployment rate show different outcomes compared to the OLS regression. More in line with expectations and the literature, the unemployment rate is significantly negatively related to property prices, indicating a reduced demand for housing in periods with high unemployment. When people lose their jobs or fear losing them, they are less likely to invest in properties, and more importantly, high unemployment leads to reduced affordability for houses, with people often struggling to afford mortgage payments or down payments for property purchases. Unexpected results can be observed with population growth, displaying a significant negative relationship at the 10% level. Vonlanthen (2023) obtained similar findings in his study, explaining that property prices are influenced more by the density of the local market rather than by population growth.

As indicated by the R-squared, this model specification explains more than half of the variation in property prices.

5.1.3 Time Effect

In the Time Effect specification, quarterly time-fixed effects have been added. Here the coefficient for bond yields switches to a positive value (1383.365) and remains significant. While controlling for country-fixed effects results in a stronger negative relationship between bond yields and property prices, controlling only for time- fixed effects yields the opposite result, leading to a positive correlation between the 2 variables. This suggests that when global conditions are absorbed, other factors specific to each country may drive this positive relationship. For example, during periods of domestic economic growth within individual countries, increased investor confidence and economic activity might lead to rising property prices, while at the same time pushing up bond yields due to higher expected returns and higher inflation expectations. Therefore, the relationship between the dependent and independent variables becomes positive after accounting for global trends.

GDP growth remains consistent with the previous regressions, displaying a positive and significant correlation with residential prices. The same findings of the OLS regression can

be observed when looking at the population growth and unemployment rate coefficients, both of which are positively and significantly correlated at the 1% level.

The R-squared of 61% is the highest across all the panel specifications.

5.1.4 Two-ways Effect

In analyzing the results of the Two-ways Effect specification, the main finding is represented by the weak and insignificant relationship between interest rates and property prices, with a bond yield coefficient of -225.884. Fixed effects estimation removes all variation between groups and focuses entirely on variation within groups, essentially assessing how changes in the dependent variable (y) within each group are associated with changes in the independent variable (x) within the same group (Dieleman and Templin, 2014). In the context of a two-way fixed effects panel regression, this approach accounts for both group-specific and time-specific fixed effects, controlling for unobserved heterogeneity across both dimensions. Therefore, this specification indicates that, when controlling for both dimensions, bond yields do not have a statistically significant impact on real estate prices. Controlling for only country-fixed effects resulted in a stronger negative relationship compared to the OLS while controlling for only time-fixed effects yielded a positive relationship. Given that when controlling for both country and time-fixed effects the correlation is still negative, the stronger negative relationship resulting from the country-fixed effect regression more than offset the positive one yielded by the time-fixed effect regression, however, the overall effect is diluted, leading to a weaker and non-significant relationship. By including both country and time-fixed effects, the model controls for several potential confounding variables. The inclusion of these controls may absorb much of the variability that could otherwise be attributed to the bond yields, leaving less variation for the bond yields themselves to explain. The Two-way Effect specification reveals that the association of bond yields with real estate prices is smaller than previously observed, or it might suggest that other factors play a more dominant role. Moreover, the insignificance of this relationship may also be caused by the increased complexity this regression entails. Adding fixed effects for each quarter of the sample period can reduce the statistical power of the model posing challenges in estimating the relationship between interest rates and property prices. This may mask the true effect of interest rates on property prices, contributing to the observed insignificance in the regression. Therefore, the two-way fixed effect panel regression presents a trade-off between its advantages in capturing both the time and country-specific effects and its challenges derived from the

increased complexity that impacts the significance of the relationship.

GDP growth presents the same results as in all the other specifications, with a significant positive coefficient of 0.347. Unemployment shows a significant negative relationship (-5.953), indicating that when accounting for both sets of fixed effects, higher unemployment rates are associated with lower real estate prices, aligning with economic expectations.

Population growth, on the other hand, shows an insignificant positive sign, replicating the findings obtained with the OLS regression.

In contrast with the other specifications, the adjusted R-squared of 0.08 indicates that, after adjusting for the number of predictors, only 8% of the variance in real estate prices is explained by the model. While the OLS, Country Effect and Time Effect specifications use more variability in the data to explain real estate prices, the Two-way Effect regression applies stringent control over both country-specific and time-specific unobserved factors, absorbing a lot of the explanatory power and leading to a regression that explains less of the total variability.

5.1.5 Overall considerations

In three out of the four panel specifications employed, the relationship between residential prices and bond yields appears to be negative, even though it is not significant when accounting for both country and time-fixed effects. This finding is in line with the literature and with most of the empirical studies that analyzed this relationship. However, a controversial result is obtained when employing the panel regression with only time-fixed effects. Here, the bond coefficient is positive and highly significant.

The GDP growth coefficient is consistent across all the regressions, always displaying a positive sign and being statistically significant at the 1% level. Population growth, in line with expectations, shows a positive sign in all the regressions except for the Country Effect. On the other hand, the unemployment effect is less constant, with a negative sign in the Country and Two-ways regressions and a positive sign in the OLS and Time Effect regressions.

The R-squared always explains more than half of the variation in the dependent variable, with the exception of the Two-way Effect regression, which presents a much lower R-squared.

5.2 Panel regression – European Economic Area

Table 7: Regression model for European Economic Area

Table 7 shows the results of the four panel specifications for the dataset that focus on countries members of the European Economic Area (EEA). Standard errors are in parentheses.

	Dependent variable:			
	Prices			
	OLS	*country effect*	*time effect*	*twoways effect*
	(1)	(2)	(3)	(4)
Bonds	−1,945.631***	−2,498.269***	613.030**	−7.113
	(115.608)	(109.770)	(247.678)	(242.180)
GDP	0.412***	0.061	0.375***	0.114***
	(0.035)	(0.051)	(0.030)	(0.042)
Population	−0.024	−0.058*	0.093***	0.039
	(0.038)	(0.033)	(0.033)	(0.027)
Unemployment	−1.650***	−3.334***	−4.189***	−7.960***
	(0.569)	(0.695)	(0.578)	(0.820)
Constant	283.982***			
	(9.178)			
Observations	874	874	874	874
R^2	0.426	0.437	0.347	0.178
Adjusted R^2	0.424	0.428	0.249	0.044
Note:				*p<0.1; **p<0.05; ***p<0.01

Note: Regression results with property prices as dependent variable; model includes OLS, country effect, time effect, and two-ways effect (874 observations) for European Economic Area.

Focusing only on countries belonging to the European Economic Area, some variables present very similar results, while others show slight differences.

Looking at the relationship between bond yields and property prices, the results are consistent with the ones observed in the previous sample, displaying a negative correlation in all but the Time Effect specification. However, the bond coefficient of the Time Effect regression is statistically significant only at the 5% level and displays a weaker relationship compared to the previous sample (613.030 vs 1383.365), this is due to the reduced heterogeneity of the countries belonging to the EEA.

Very similar results can be also observed in the relationship between GDP growth and residential prices, where the GDP coefficient is again positive across all the panel specifications. In this subsample, however, the GDP coefficient resulting from the Country Effect regression is not significant.

Slightly different results are found when looking at the population variable. The population growth coefficient presents a negative sign when the OLS regression is employed, as opposed to the positive sign observed in the previous group. Nonetheless, in both cases, the relation is not significant. Moreover, the same coefficient in the Country Effect regression is less significant than in the previous group, while still maintaining the negative sign.

Lastly, while the previous sample showed inconsistent results regarding the relationship between changes in the unemployment rate and property prices, focusing only on EEA member countries reveals a significant negative relationship across all four specifications. This result is more in line with the literature and can be attributed to the fact that focusing on the EEA region better isolates the impact of regional policies and economic conditions that are more consistent across these nations while might differ significantly when considering a more diverse set of countries. This assumption is confirmed by the fact that when controlling for country-specific factors (by adding country-fixed effects), the unemployment coefficient is negative in the previous sample as well, as shown in both the Country Effect and Two-ways Effect regressions.

When focusing on EEA member countries, the R-squared is slightly higher when both country and fixed effects are included but is lower across all the other panel regressions.

6. CONCLUSION

This thesis aimed to unveil the relationship between government bond yields and real estate prices within a sample of 20 advanced countries and, more specifically, 12 countries in the European Economic Area. The results reveal a complex connection between yields and real estate prices. The significant negative correlation established through OLS and country fixed effects regressions is consistent with traditional economic theory, suggesting that higher bond yields (which usually means higher mortgage rates) dampen demand for housing and decrease property prices. This inverse relationship was even stronger in the country fixed effects regression, hinting that controlling for country-specific factors could amplify the effect of bond yields on real estate prices. Conversely, the time-fixed effects regression told a different story, recording a positive bond yield-real estate price relationship. It suggests that in some episodes, the large decline in global economic conditions or crises may overrule the usual mechanics of interest rate channels. As a result, this high positive correlation anomaly occurs. The result is a direct affront to the belief in a universal solution of monetary policy, but it also highlights the importance of the time horizon over which policy maneuvers are typically made. The two-way fixed effects produced a negative not-significant association between bond yields and real estate prices. This hints that the direct impact of bond yields may be drowned out by other macro-forces when controlling for the broad spectrum of cross-sectional and temporal variations. The reduced importance of this form in the model highlights that other variables or possibly omitted factors may be more powerful than previously believed.

The relationship was further explained by adding additional macroeconomic variables, such as GDP growth, population growth, and unemployment rates. Unsurprisingly, GDP growth stood as a forceful positive influence on real estate prices, illustrating the deep-rooted connection between economic well-being and the desire for housing. However, unemployment rates behaved in a dual way; they were significantly negative in the case of regressions accounting for country fixed effects or when focusing only on the EEA member countries; while in the OLS for the first sample, their significant positive relationship implies that simple models could fail to adequately reflect some complexities. The contrast in population growth effects is indicative of the heterogeneous effects of population dynamics on housing markets.

6.1 Limitations and Future Research Directions

This study was successful in largely achieving its objectives; however, given the apparent limitations of the work, a critical assessment is necessary. One of the weaknesses is represented by the sources of historical data, such as the long series on nominal residential property prices developed by the Bank for International Settlements. While these are reliable sources, they rely on different inputs such as central banks, national statistical offices, research institutes, private companies, and academic studies, therefore, this variety of sources can potentially lead to discrepancies in the compilation methods (Bank for International Settlements, 2024). A second major limitation has to do with the risk of omitted variable bias. Although the study employs various econometric regressions to control for observable factors, there may still be unobserved variables that influence both government bond yields and property prices. The omission of these factors could potentially skew the results, leading to an incomplete understanding of the relationship.

In the future, research should build on the existing knowledge and introduce broader data sets, including more macroeconomic variables. The analysis should further broaden to encompass fiscal policies, regulation, and other structural factors that could determine real estate prices. In addition, an analysis of the interactions between central bank policies and real estate markets over different economic cycles could shed light on this phenomenon over time. Moreover, providing a wider lens on emerging economies will provide a more robust picture of global real estate markets, which will allow us to explore the generalizability of relationships to a broader set of economic environments. Lastly, future research may want to also explore more sophisticated econometric methodologies to account for unobserved variables and associations that are part of the data. The various paths in this iterative process help sharpen these theories and thus can lead to better and more nuanced economic policy in the future.

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APPENDIX

Appendix 1: Description of the long series on nominal residential property prices

Table 2

Country Description	Source
Australia	Australian Bureau of Statics
From 2003 Q3 onwards: residential property prices, all dwellings (eight cities), pure price, NSA	Real Estate Institute of Australia
1970 Q1–1986 Q2: median dwelling prices, state capital	
1986 Q3-2003 Q2: residential property prices, all detached houses (eight cities), pure price, NSA	
Belgium	Statbel
From 2005 Q1 onwards: residential property prices, all dwellings, pure price, NSA	Stadim Guide de valuers immobilieres
1973 Q1-2004 Q4: residential property prices, existing dwellings, per dwelling, NSA	
1970 Q1–1972 Q4: index of small- and medium-sized dwellings	
Canada	CREA: The Canadian real Estate Association
From 2005 Q1 onwards MLS® Home Price Index	Multiple Listing Service
1980 Q1-2004 Q4: national residential average price, NSA	
1970 Q1–1979 Q4: average price of existing homes	
Switzerland	Wüest und partner
From 1970 Q1 onwards: unweighted average of owner occupied flats and houses nationwide	
Germany	BIS calcutations
From 2014 Q1 Onwards House Price Index (Federal Statistical Office)	Federal Statistical Office
2006 Q1-2013 Q4: Residential property prices, all owner occupied dwellings, pure price, NSA	Deutsche Bundesbank data based on bulwiengesa AF
1995 Q1-2005 Q4: terraced houses and owner-occupied apartments in 125 cities	
1990 Q1-1994 Q4: terraced houses and owner-occupied apartments in 100 towns in western Germany	
1975 Q1-1989 Q4: new terraced houses and owner-occupied apartments in 50 towns in western Germany	
1970 Q1-1974 Q4: construction prices of new residential buildings for western Germany.	
Denmark	Statistics Denmark
From 2002 Q1 onwards: all types of dwellings nationwide	
1970 Q1-2001 Q4: residential property prices, single-family houses, pure price, NSA	
Spain	Instituto Nacional de Estadistica
From 2007 Q1 onwards: residential property prices, all dwellings, pure price, NSA	Ministerio de Fomento
1987 Q1-2006 Q4: residential property prices, all dwellings, per m2, NSA	Bank of Spain
1975 Q1–1986 Q4: house prices in the capital city Madrid area	Banco Hipotecario
1971 Q1–1974 Q4: OECD historical statistics	OECD
Finland	Statistics Finland
From 2010 Q1 onwards: residential property prices, all dwellings, pure prices, NSA	
2005 Q1-2009 Q4: residential property prices, existing dwellings, per m2	
1983 Q1-2004 Q4: residential property prices, existing flats and terraced houses, total, per m2, NSA	
1970 Q1–1982 Q4: existing flats	
France	INSEE
From 2000 Q1 onwards: residential property prices, all dwellings, pure price, Q-All, NSA	
1996 Q1-1999 Q4: residential property prices, existing dwellings, pure price, Q-All, NSA	
1970 Q1–1995 Q4: J Friggit, "Produits dérivés, un sous-jacent immobilier", Ministère de l'Equipement	
United Kingdom	Office for National Statistics
From 2005 Q1 onwards: residential property prices, all dwellings (ONS), per dwelling, NSA	
1968 Q2-2004 Q4: residential property prices, all dwellings (ONS), per dwelling, NSA (historical data)	
Ireland	Central Statistics Office
From 2005 Q1 onwards: residential property prices, all dwellings, pure price, NSA	Department of Environment Community and Local Governm
1970 Q1–2004 Q4: price index, new houses	
Italy	Bank of Italy
From 1990 Q1 onwards: residential property prices, all dwellings, pure price, NSA	BIS calculation based on bank of Italy Occasional Paper
1971 Q1–1989 Q4: Bank of Italy historical residential property price index	
1929 Q1-1970 Q4: Bank of Italy Occasional Paper	
Japan	Ministry of Land, Infrastructure, Transport and Tourism
From 2008 Q2 onwards: residential property prices, all dwellings, pure price, NSA	Japan Real estate Institute
1955 Q1-2008 Q1: land prices, residential, urban areas, per m2 , NSA	
Korea	Bank of Korea
From 1986 Q1 onwards: residential property prices, all dwellings, pure price, NSA;	Korea Appraisal Board
1975 Q1-1985 Q4: land prices (residential and non-residential)	
Netherlands	Statistics Netherland
From 2005 Q1 onwards: residential property prices, all dwellings, pure price	Nederlandse Vereniging van Makelaars
1995 Q1-2004 Q4: residential property prices, all existing dwellings, pure price, NSA	
From 1976 Q1–1995 Q4: existing dwellings.	
1970 Q1–1975 Q4: sales of houses and flats brokered by real estate agents	
Norway	Statistics Norway
From 1992 Q1 onwards: residential property prices, all (only existing from 2012) dwellings, pure price, NSA	Central Bank of norway
1970 Q1–1991 Q4: house prices, from Ø Eitrheim and S Erlandsen, "House price indices for Norway, 1819–2003"	
New Zealand	Quotable Value Limited, New Zealand
From 1979 Q4 onwards: residential property prices, all dwellings, per dwelling, NSA	
1970 Q1–1979 Q3: quarterly house price index – main urban areas; Quotable Value Limited	
Sweden	Statistics Sweden
From 2005 Q1 onwards: all types of dwellings nationwide	
1986 Q1-2004 Q4: residential property prices, all owner-occupied houses, per dwelling, NSA	
1970 Q1–1985 Q4: index of owner-occupied one- and two-dwelling buildings	
United States	Federal Reserve
From 1975 Q4 onwards: residential property prices, existing dwellings, per dwelling, SA	National Association of Realtors
1970 Q1–1975 Q3: average sale price of existing single-family homes	
South Africa	ABSA Group
1966 Q1-2000 Q4: Residential property prices, all middle segment dwelling, per dwellings	First National Bank
From 2001 Q1: Residential property prices all dwellings	