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A Hybrid Statistical–Fuzzy Decision Framework for Housing and Rental Price Dynamics: Evidence from Spain

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ABSTRACT

Real estate markets demand a nuanced comprehension of the evolving interplay between housing prices and rental rates. Traditional economic theory posits that rents drive property prices; however, contemporary evidence indicates a reversal, suggesting that fluctuations in housing prices can, in fact, influence rent levels. This study introduces a decision-support analytics framework to address this phenomenon, combining fractional integration (ARFIMA), fractional cointegration (FCVAR), and time–frequency domain causality analysis. Examination of the Spanish housing market yields three key insights. First, housing prices display persistent responses to shocks, causing rental rates to revert to equilibrium only over intermediate periods. Second, causality analyses reveal that property values significantly influence rental dynamics, confirming a directional effect. Third, long-term cointegration is evident, implying that rental adjustments facilitate the realignment of the housing–rental system towards equilibrium. The proposed framework equips real estate investors, policymakers, and urban planners with enhanced tools for decision-making, supporting refined risk assessment, optimal investment timing, and evidence-based housing affordability strategies. Overall, the findings advance management and economic policy-making by demonstrating how sophisticated time-series methodologies can inform sustainable housing market interventions.

1. Introduction

Housing costs and rental prices are central indicators of economic dynamics within urban societies [15]. In Spain, where the real estate market has been influenced by a complex interplay of economic, social, and political forces, a sophisticated analytical approach is necessary. The real estate sector is inherently intricate, with each property representing a unique combination of attributes and qualities [13]. Drawing from classical economic theory, as highlighted by Villalba et al. [25], an asset's value is calculated by discounting the expected stream of future revenues it generates. When applied to real estate—encompassing land, residential units, and buildings—this approach evaluates an asset based

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on the present value of projected rental incomes.

Landlords set rental rates according to local market dynamics, socio-economic conditions, and various other determinants, including population growth, economic activity, household income levels, demand preferences, and housing supply. Prior research categorizes rental determinants into economic and non-economic factors. Economic drivers include variables such as existing demand levels and household earnings [26]. Non-economic factors relate more closely to demographic patterns and property characteristics, encompassing regional population growth, site location, construction year, physical features such as floor area, number of rooms and bathrooms, architectural style, building type, and the presence of amenities like plumbing, swimming pools, or natural gas supply.

Contrary to traditional assumptions, real estate practitioners often argue for reverse causality, where rising property values drive rental increases, particularly during periods of rapidly appreciating housing prices [14]. Empirical observation indicates that when acquisition costs escalate, landlords tend to adjust rental prices upwards to offset higher property expenses. While conventional economics may consider property purchase prices as sunk costs irrelevant to future decision-making, behavioural economics demonstrates that such sunk costs can influence risk-taking behaviour, with individuals who have invested heavily potentially adopting riskier strategies [6]. Evidence from housing markets supports this perspective. Buyers who acquire properties at higher prices typically exhibit greater tolerance for risk and may overprice subsequent sales to mitigate potential losses, indirectly shaping rental market dynamics. Original purchase prices, therefore, act as sunk costs that affect both selling strategies and rental market behaviour [20].

Despite these observations, a direct empirical causal link between housing prices and rents remains underexplored. Although data often show a positive correlation, this does not guarantee unidirectional causation; negative feedback effects may also emerge. Standard economic theory posits that higher rents can incentivize homeownership, influencing property valuations, and that expectations of future rents can affect current property prices. Over the past decade, experimental methods in real estate research have advanced significantly, particularly in areas such as land assembly [4; 7; 17; 19; 23; 27] and property pricing strategies [2; 5; 8; 11; 12].

This study contributes to existing literature by statistically examining the characteristics of housing and rental variables through advanced econometric techniques, exploring their interdependencies. Spain provides a relevant case study, with approximately 60 percent of residents owning their homes (75.2 percent according to the National Institute of Statistics, February 2023), reflecting a cultural tendency to save and invest in property during uncertain periods—a phenomenon known as Ownership Culture [9]. Employing fractional integration methods and combining quantitative analysis with fuzzy logic, this research develops a dynamic decision-support framework that captures the interplay between housing prices and rents. The approach delivers nuanced insights to investors, policymakers, and housing market participants, offering enhanced predictive capabilities in the Spanish housing context.

2. Methods

Initially, researchers have applied long-memory modelling to examine the statistical characteristics of both series, with particular attention to persistence and mean-reverting behaviour. The rationale for employing this approach is threefold: (1) it facilitates the determination of whether a series exhibits short- or long-memory properties, which directly influences shock persistence and the robustness of forecasts; (2) it allows for more precise classification of series as stationary or non-stationary, while revealing the degree of fractional differencing required to stabilise statistical properties over time; and (3) it elucidates how each series responds to external disturbances, indicating whether reversion to a long-term mean occurs naturally or requires external adjustment. Multivariate analyses were subsequently conducted to examine predictive interdependencies between the variables.

Causality assessments are critical for establishing whether changes in one series contain predictive information about future values of another or if observed associations are spurious. Two distinct causality methodologies were employed in this study. First, a Granger causality test was conducted within a vector autoregressive (VAR) framework, complemented by frequency-domain analysis to assess intervariable relationships. Second, the Breitung and Candelon test was implemented in the frequency domain, allowing identification of causal linkages across different temporal horizons—short-, medium-, and long-term—and determining their statistical significance. To evaluate long-run equilibrium among long-memory variables, this study employed a fractional cointegration approach. Unlike conventional cointegration techniques, this method captures slow-adjusting dynamics and persistent patterns that might otherwise remain undetected. Consequently, it provides a flexible and robust framework to analyse the interrelationship between housing prices and rental rate dynamics.

3. Data

Rental price data for Spanish housing were obtained from the Eikon Reuters platform, a commercial repository offering extensive financial and economic datasets, analytical tools, and high-quality reporting. The rental figures are reported as annual percentage variations and are categorised according to the ECOICOP (European Classification of Individual Consumption by Purpose) system, which forms part of the broader Consumer Price Index (CPI) framework. Residential property price information was sourced from the Economic Research Division of the Federal Reserve Bank of St. Louis via its official website. The dataset spans the period from January 1997 to July 2023, with observations recorded on a quarterly basis. A comparative visualisation of the two-time series over the entire study period is provided in Figure 1.

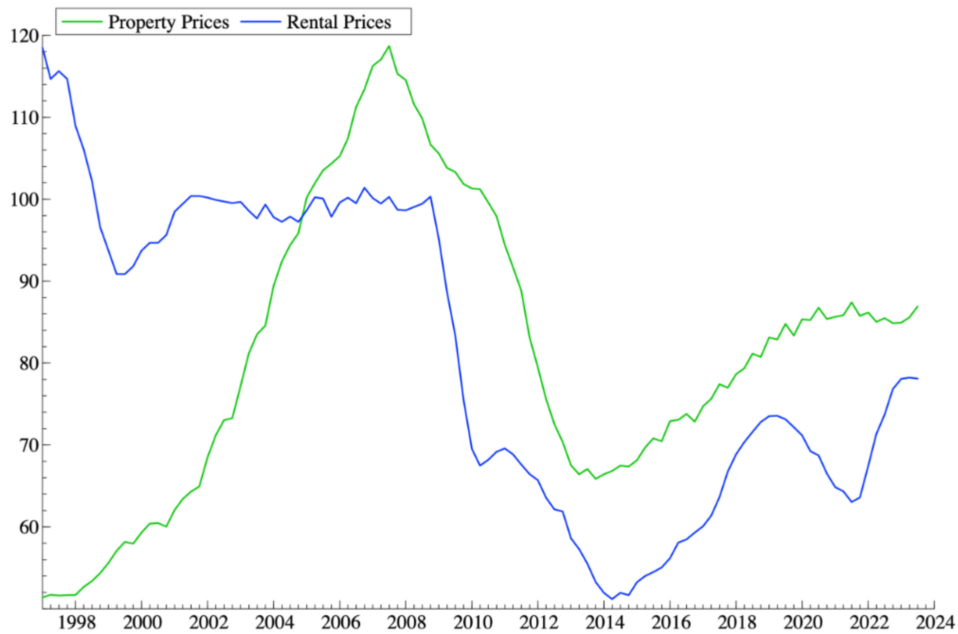

Fig.1: Property and Rental Prices

Figure 1 illustrates the relationship between property values and rental prices. Housing prices in Spain experienced a pronounced increase prior to 2007, driven largely by a speculative bubble supported by accommodative credit conditions, including easy access to loans and low interest rates.

This rapid escalation was followed by a sharp decline, reflecting the impact of the global financial crisis, with a gradual recovery observed around 2012. More recent fluctuations suggest that the market continues to undergo adjustment processes [16]. In contrast, rental prices remained relatively stable until 2007, after which they declined during the economic downturn, likely reflecting reduced demand and broader financial stress. The subsequent recovery from early 2013 indicates a return toward economic normalization, while recent volatility may be associated with shifts in housing demand, affordability constraints, and emerging factors such as the COVID-19 pandemic.

3.1 Unit Roots

Time-series modelling is a cornerstone of statistical and econometric analysis, often utilizing either univariate or multivariate regression frameworks to examine the behavior of individual variables and the relationships among multiple variables. A critical preliminary step in applying these models is to characterize the properties of the underlying time series. The Dickey-Fuller test, a widely employed unit root assessment, determines whether a series is stationary (I(0)), indicating the absence of a unit root, or non-stationary (I(1)), signifying the presence of a unit root. When residuals from the basic model exhibit autocorrelation, the augmented Dickey-Fuller (ADF) test is recommended to ensure the robustness and reliability of the results.

3.2 ARFIMA (p, d, q) Model

Following the determination of integration ranks for each series via conventional unit root (UR) tests, a more sophisticated analytical procedure was implemented. Building on preliminary analyses, researchers applied the principle of fractional integration, denoted as I(d). Unlike models that restrict the differencing parameter to integer values, I(d) allows d to assume any real number, thereby achieving stationarity under less restrictive conditions. For non-stationary series, fractional differencing stabilizes the series while more effectively capturing long-range dependencies compared to traditional integer differencing. This approach enhances statistical power and is particularly suitable when the data-generating process is believed to exhibit fractional integration characteristics. A notable advantage of I(d) models is their ability to capture persistence, whereby data points remain correlated over time, even if widely separated. In this study, an ARFIMA (p, d, q) model—extending the ARIMA framework through fractional differencing—was employed to account for the long-memory properties of the series. The model can be formally represented as follows.

$$(1-L)^d x_t = u_t, t = 1, 2, \tag{1}$$

Equation (1) defines a time series that follows the process of fractional integration of order d, denoted as $x_t \sim I(d)$, where d can be any real number. In this formulation, L is the lag operator such that $Lx_t = x_{t-1}$, and $u_t \sim I(0)$ refers to a stationary process with finite and positive spectral density at zero frequency, implying a weak dependence over time. When u_t follows an ARMA (p, q) process, the resulting series x_t follows an ARFIMA (p, d, q) model. The term $(1-L)^d$, derived through binomial expansion, allows for fractional differences. In contrast to conventional differencing methods, fractional differencing implies that every observation within a series is affected by a potentially infinite sequence of preceding values. Higher values of d correspond to greater persistence, reflecting stronger long-range dependence [3].

Unlike standard differencing techniques, fractional differencing posits that each observation in a series is shaped by a potentially infinite, unknown sequence of past values. As the differencing parameter d increases, the persistence of the series strengthens, indicating pronounced long-range dependence. The value of d provides key insights into the statistical properties of the series: when d = 0, the series displays short memory, with correlations diminishing rapidly over time; when 0 < d < 0.5, the series is covariance stationary, whereas d ≥ 0.5 signifies non-stationarity. Values of d ≥ 1 indicate that the series tends to revert to its long-term mean, while d < 1 implies that shocks are temporary, allowing mean reversion. In this study, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were employed to select the optimal ARFIMA model, achieving a balance between model complexity and fractional integration.

3.3 Breitung-Candelon Causality Test

The causality framework offers a robust approach for determining whether interactions between two time series manifest over short- or long-term horizons [24]. Unlike conventional causality tests, this methodology decomposes Granger causality across multiple frequency domains. This is accomplished through spectral decomposition of the variables, utilizing coherence measures and the bivariate spectral density matrix. Such an approach enables a more nuanced analysis, revealing both short- and long-term causal effects and providing detailed insights into the distinct temporal structures underlying the dynamic interrelationships between the series. A VAR process of order p modelling the dynamic interaction of the two-time series, x and y, is given by:

$$x_t = \alpha_1 x_{t-1} + \alpha_p x_{t-p} + \beta_1 y_{t-1} + \cdots + \beta_p y_{t-p} + \beta_{1t} \qquad (2)$$

To evaluate whether y causes x at a given frequency w, the null hypothesis $H_0: M_{y\to x}(w) = 0$ was tested to evaluate whether y causes x at a given frequency w. This represents a linear constraint of the following form.

$$R(w)\beta = 0 \qquad (3)$$

Where, β denotes the coefficient vector for y, and R(w) represents a matrix defined as follows.

$$R(w) = \begin{bmatrix} \cos(w)\cos(2w)\ldots\cos(pw) \\ \sin(w)\ \sin(2w)\ldots\sin(pw) \end{bmatrix} \qquad (4)$$

The F-statistics used to test this restriction approximately follow an $F(2, T-2P)$ distribution for $w \in (0, \pi)$, where T is the sample size.

Integration often serves as a theoretical basis for interpreting the frequency-domain Granger causality test. When cointegration is present, Equation (2) is applied to x_t rather than its first difference Δx_t. Under these conditions, long-run causality aligns conceptually with causality at zero frequency. In contrast, if the series are stationary and no cointegration is detected, causal relationships at lower frequencies indicate that one variable can still systematically predict another over extended horizons, despite the absence of a stable long-term equilibrium.

3.4 FCVAR Model

To examine the long-term relationship between the variables, the FCVAR model, as proposed by Johansen and Nielsen (2012), was employed. The model is specified as follows:

$$\Delta^d X_t = \alpha\beta' L_b \Delta^{d-b} X_t + \sum_{i=1}^{k} \Gamma_i \Delta^b L_b^i Y_t + \varepsilon_t \qquad (5)$$

In this formulation, α and β are $p \times r$ matrices where $0 \le r \le p$. The term ε_t represents a p-dimensional error term with zero meaning and a variance-covariance matrix Ω, assumed to be independently and identically distributed. Matrix β defines the long-term equilibrium, Matrices Γ_i represents the short-term dynamics, and α defines the speed of adjustment toward equilibrium

4. Results and Discussion

The empirical analysis commenced by assessing the stationarity properties of housing purchase and rental price series in Spain over the period from 1997 to July 2023. Unit root tests—including the ADF, PP, and KPSS—were employed to determine whether the series are stationary (I(0)) or non-stationary (I(1)). Establishing the correct integration order is crucial, as misclassification can lead to misleading inferences regarding variable behavior and interrelationships, particularly when underlying trends or seasonal effects are not accounted for [18]. The results of these tests are summarized in Table 2, indicating that both housing purchase and rental price series are non-stationary, exhibiting an integration order of one, I(1). This suggests that the series display stochastic trends, with shocks generating persistent deviations over time. In this context, each observation is influenced by its previous value and a random error term, causing current shocks to remain influential. To achieve stationarity, both series were different, yielding stationary series, I(0), consistent with classical unit root test expectations. Traditional procedures, however, are limited to detecting integer orders of integration. To capture more nuanced persistence and long-memory characteristics, the analysis was subsequently extended using the ARFIMA model, which allows fractional orders of integration for a more flexible representation of series dynamics.

Table 2
Unit Root Tests

	ADF			**PP**		**KPSS**	
	(i)	(ii)	(iii)	(ii)	(iii)	(ii)	(iii)
Original Data							
Property Prices	0.519	–1.7421	–1.5461	–1.7049	–1.4426	0.3985*	0.3452
Rental Prices	–1.5639	–1.7321	–1.6591	–2.0114	–1.186	1.6237	0.2543

Beyond standard unit root testing, the analysis incorporates fractionally integrated process models, specifically the ARFIMA(p, d, q) framework, to explore the presence of fractional integration in Spanish housing purchase and rental price series. This approach is particularly valuable when traditional unit root tests may fail to detect persistent fractional characteristics within the data. Model selection for identifying optimal autoregressive (AR) and moving average (MA) orders was guided by the Akaike Information Criterion (AIC) and the BIC. Nevertheless, these criteria may be less effective under fractional integration conditions [1]. Various ARFIMA configurations were examined, with AR and MA orders constrained to values below 2, and parameters estimated via maximum likelihood estimation [10]. Table 3 summarizes the estimated parameters for each series, including AR, MA, and fractional differencing (d) coefficients. The ARFIMA methodology offers several advantages over conventional unit root procedures: it accommodates non-integer differencing, effectively captures persistence, models long-memory effects with greater accuracy, and provides a coherent framework for analyzing and forecasting time series dynamics.

Table 3
Results of Long Memory Tests

Data Analyzed	**Sample Size (Days)**	**Model Selected**	**d**	**Std. Error**	**Interval**	**I(d)**
Original Data						
Property Prices	107	ARFIMA (0, d, 0)	1.42	0.055	[1.33, 1.51]	I(1)
Rental Prices	107	ARFIMA (2, d, 1)	0.65	0.163	[0.38, 0.92]	I(d)

The results, summarized in Table 3, indicate that the estimated fractional differencing parameter, d, for residential property prices exceeds 1, specifically d = 1.42, whereas for rental prices, d remains below 1. Both series therefore exhibit fractional integration, denoted as I(d). The property price series' d value above 1 suggests that the null hypothesis of a unit root process, I(1), cannot be rejected. A statistically significant estimate exceeding 1 reflects a pronounced long-memory process, implying that Spain's non-stationary property prices are heavily influenced by historical trends. This high persistence indicates that economic shocks or perturbations leave enduring effects on the series, hindering natural reversion to long-term equilibrium and complicating both forecasting and stabilization efforts.

In contrast, the rental price series, with d = 0.65, also exhibits long-memory characteristics but is comparatively closer to stationarity than the property price series. While not yet stationary, the estimate suggests that shocks to rental prices exert long-term effects, yet the series is likely to gradually return to its mean. Thus, although prior events continue to influence rental dynamics, the lower d value implies greater potential for future stabilization, indicating comparatively higher resilience in the rental market. A univariate analysis was initially conducted to assess potential interdependence between the two price series, which was subsequently extended within a bivariate causality framework to identify directional relationships. Specifically, if past values of one series improve the predictability of another, this indicates the presence of Granger causality. To determine the directionality of influence between property prices and rental rates, a Granger causality analysis was performed within a VAR framework. The results of this analysis are presented in Table 4. The two series incorporated into the VAR model are as follows:

$$PP_t = \alpha_1 + \sum_{i=1}^{n} \beta_i RHP_{t-i} + \sum_{j=1}^{m} \delta_j PP_{t-j} + \epsilon_{PP_t} \quad (5)$$

$$RHP_t = \alpha_2 + \sum_{i=1}^{n} \theta_i RHP_{t-i} + \sum_{j=1}^{m} \psi_j PP_{t-j} + \epsilon_{RHP_t} \quad (6)$$

In this context, PP refers to property prices, whereas RHP represents rental housing prices. The error terms ϵ_{PP_t} and ϵ_{RHP_t} are assumed to be white noise processes that are mutually uncorrelated. Lag lengths m and n in the equations denote the maximum number of lags selected for each variable in the VAR model. The application of the VAR methodology is justified under specific conditions. Firstly, the approach is valid when the variables are integrated of order zero or one. As noted in the preceding section, both series exhibit comparable integration properties and are characterised as I(d). Secondly, relationships can be estimated either in levels or first differences using ordinary least squares (OLS), if the integration order does not exceed one. Thirdly, in the absence of cointegration among I(0) variables, no long-term equilibrium relationship is anticipated. In this study, two Granger causality hypotheses were examined. The first hypothesis tested whether property prices possess predictive power over rental prices.

$H_0: \sum_{i=1}^{n} \beta_i = 0$ (Property prices do not Granger-cause rental prices).

$H_1: \sum_{i=1}^{n} \beta_i \neq 0$ (Property prices are Granger cause rental prices).

The second hypothesis investigates the converse relationship:

$H_0: \sum_{j=1}^{m} \psi_j = 0$ (Rental prices do not Granger-cause property prices)

$H_1: \sum_{j=1}^{m} \psi_j \neq 0$ (Rental prices do Granger-cause property prices).

The Granger causality results, summarised in Table 4, examine the directional relationship between property prices and rental prices. The findings reveal a discernible correlation between the two series; however, rental prices do not exhibit a statistically significant influence on property prices, indicating a unidirectional causal link. Consequently, these results suggest that property prices possess predictive capacity for rental prices, providing valuable information for forecasting trends in the rental housing market.

Table 4
Results of Granger Causality Test

Direction of Causality	Lags	Prob.	Decision	Outcome
Property Prices → Rental Prices	9	0.0183	Reject Null	Residential property prices are causing behavior in rental housing prices in Spain.
Rental Prices → Property Prices	9	0.3468	Do not Reject Null	Rental housing prices do not cause residential property prices in Spain.

Figure 2 presents the results of the unit root tests—ADF, PP, and KPSS—applied to the property and rental price series. Each test was conducted under multiple model specifications, denoted as (i), (ii), and (iii). The ADF and PP test statistics generally indicate non-stationarity, whereas the KPSS results are mixed, suggesting that the series exhibit partial stationarity under certain specifications.

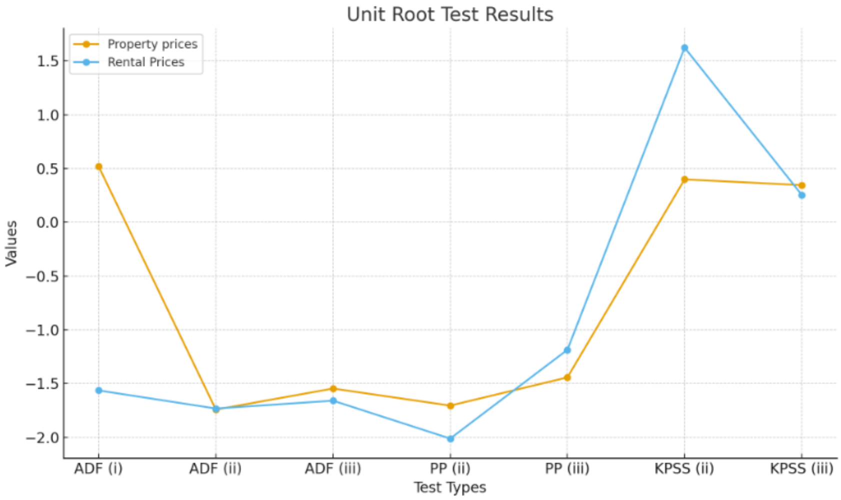

Fig.2: Unit Root Test Results for Property and Rental Prices

Figure 3 depicts the p-values from the bidirectional Granger causality tests. The p-value for the effect of property prices on rental prices is 0.0183, which falls below the 0.05 significance threshold (indicated by the red dashed line), leading to the rejection of the null hypothesis and confirming that property prices exert a statistically significant influence on rental prices. Conversely, the p-value for the effect of rental prices on property prices is 0.3468, exceeding the 0.05 significance level, suggesting that there is no evidence of reverse causality.

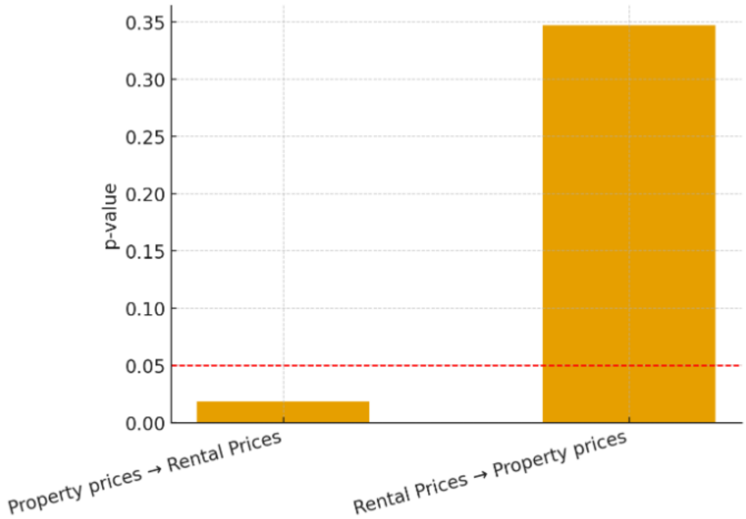

Fig.3: Granger Causality Test Results Indicating Property Prices

Figure 4 illustrates the estimated long-memory parameters (d) for both residential property and rental price series derived from the ARFIMA models. The property price series exhibits a d value of 1.42, with a narrow confidence interval of [1.33, 1.51], classifying it as integrated of order one, I(1), and indicating strong persistence and non-stationarity. In contrast, the rental price series has a smaller d value of 0.65, with a wider confidence interval [0.38, 0.92], suggesting fractional integration, I(d), and moderate long-memory characteristics. These results indicate that trends in property prices are more enduring over time compared to those in rental prices.

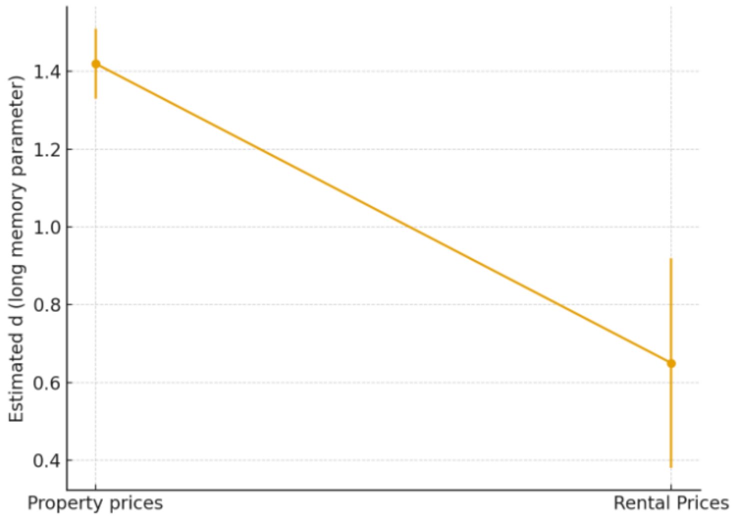

Fig.4: Long Memory Test Results Indicating the Estimated d Parameters and Confidence Intervals

Following the time-domain causality analysis between property and rental prices, the study extended the investigation to the frequency domain using the Breitung and Candelon method. This approach allows the decomposition of causal relationships across different time horizons. The results of the frequency-domain analysis are summarised in Table 5. Preliminary results indicate that property prices exert a significant influence on rental prices, while the reverse effect is statistically negligible. The Wald test statistics and corresponding p-values, reported in Table 5, corroborate this finding, demonstrating significance across all frequency bands—short-, medium-, and long-term. These outcomes underscore the enduring impact of property price fluctuations on the Spanish rental market. After confirming that the observed causal relationship is statistically robust and free from spuriousness, the analysis proceeds to examine the long-term equilibrium relationship and co-movements between the two series.

Table 5
Breitung and Candelon Frequency Domain Causality Test Results

Hypothesis	**Long Term ($\omega = 0.05$)**	**Medium Term ($\omega = 1.5$)**	**Short Term ($\omega = 2.5$)**
Original Time Series			
Property Prices →Rental Prices	9.066* (0.011)	10.12* (0.006)	10.12* (0.006)

* The asterisk denotes that the causal relationship is statistically significant at the 5% level. The values in parentheses indicate the p-values of the F-statistics calculated for the corresponding frequency (ω) values.

To capture these dynamics, the study employs the FCVAR model, an extension of the conventional Cointegrated VAR (CVAR) framework. The FCVAR model provides enhanced flexibility by accommodating fractional integration and long-memory processes within cointegrated systems (Louzada et al., 2025). The estimation results for the FCVAR model are presented in Annex Table 6.

Table 6
Results of the FCVAR Model

	$d \neq b$	Cointegrating Equation Beta	
		Property Prices	Rental Housing Prices
Panel I:	$d = 0.762\ (0.202)$	1.000	5.692
Property Prices	$b = 0.762\ (0.237)$		
vs Rental Prices	$\Delta^d\left(\begin{bmatrix} Property \\ Rental \end{bmatrix} - \begin{bmatrix} 51.163 \\ 6.468 \end{bmatrix}\right) = L_d \begin{bmatrix} -0.036 \\ -0.003 \end{bmatrix} \nu_t + \sum_{i=1}^{2} \hat{\Gamma}_i \Delta^d L_d^i (X_t - \mu) + \varepsilon_t$		

The interpretation of the FCVAR results centres on two core components: the fractional integrating parameters (d and b) and the cointegrating vector β. The parameters d and b jointly determine the degree of persistence and the form of long-run adjustment within the system. In this study, the estimated integration order of the individual series is d = 0.762, while the cointegrating relation is associated with b = 0.762. Since the difference (d − b) equals zero, the resulting cointegration residuals are covariance stationary, I(0). This finding indicates that although both the housing purchase and rental price series are individually non-stationary (as d ≥ 0.5), a unique linear combination of the two yields an equilibrium relation free from stochastic drift. In practical terms, this signifies the presence of a long-run equilibrium mechanism binding the two markets. Deviations from this equilibrium are temporary, with the system naturally converging back to its steady-state path without requiring additional differencing or exogenous corrective intervention.

From a policy standpoint, the finding that the two series are cointegrated with (d − b) = 0 implies that interventions in either market will ultimately transmit to the other [21]. Consequently, regulatory measures such as subsidies, taxation schemes, mortgage conditions, or rent caps cannot be designed in isolation. Any policy directed at moderating property purchase prices will, over time, exert pressure on rental price movements, and the reverse holds. This interdependence underscores the need for coordinated housing strategies that explicitly account for cross-market spillover effects to avoid destabilising the long-run equilibrium relationship between the two price dynamics.

Turning to the cointegrating vector, the estimated beta coefficients indicate that rental prices exhibit approximately 5.692 times the degree of long-run adjustment relative to property prices. Interpreted economically, a one-unit increase in property values is associated with an approximate 5.692-unit increase in rental levels in order to preserve the equilibrium linkage between the two series [22]. The magnitude of this beta implies that rental prices are substantially more responsive to fluctuations in the property market. Such heightened sensitivity likely reflects underlying structural features of the Spanish housing sector, including persistent demand pressures, affordability constraints, and the relative flexibility of rental contracts compared with the slower adjustment mechanisms present in property transactions. The result therefore portrays the rental market as a comparatively elastic segment that rapidly internalises shocks originating from changes in asset values.

5. Conclusion

The real estate sector operates within a multifaceted system shaped by both economic drivers and behavioural factors. Conventional economic reasoning assumes rental values move proportionally with property prices; however, behavioural economics suggests that rising property values may prompt owners to raise rents, even at the risk of reduced occupancy. This study explores that relationship in Spain by analysing the interaction between residential property prices and rental prices over quarterly data from January 1997 to July 2023. The analysis employs advanced econometric techniques, beginning with fractional integration to assess persistence and shock responses. The rental price series demonstrates mean reversion, with d < 1, while property prices exhibit unit root behaviour (d > 1), indicating that shocks to housing values have long-lasting effects. A VAR-based Granger causality test reveals a one-directional relationship running from property prices to rents. This result is validated across different time horizons through frequency-domain causality testing. Fractional cointegration analysis further confirms a stable long-run equilibrium, where both variables are I(1) but their linear combination is stationary (I(0)). The estimated long-run coefficient suggests that a one-unit increase in property prices corresponds to an approximate 5.692-unit rise in rental prices. This outcome indicates that the rental market adjusts more strongly to shifts in housing values. Consequently, policies aimed at stabilizing property prices—such as restricting speculative investment or regulating supply—will transmit directly into rental market conditions. Stabilizing rental price volatility is therefore essential for maintaining housing affordability. Moreover, because property prices adjust more slowly aftershocks, policy interventions (e.g., fiscal support or monetary easing) may be necessary to reinforce recovery in the housing market, whereas rental prices tend to normalize with fewer direct interventions.

Conflict of Interest and Authorship Conformation Form

All authors have participated in (a) conception and design or analysis and interpretation of the data; (b) drafting the article or revising it critically for important intellectual content; and (c) approval of the final version.

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The authors have no affiliation with any organization with direct or indirect financial interests in the subject matter discussed in the manuscript.

Data Availability Statements

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical Approval

This article does not include any studies with human participants performed by any of the authors.

Informed Consent

This article does not include any studies with human participants performed by any of the authors.

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