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The linked movement of the housing market and stock market in the G7 asset economy

Jae-Ho Yoon
Department of Urban Design & Planning, Hongik University, South Korea
beowulfkorea@gmail.com
ORCID 0000-0001-9111-5660

Young-Wan Goo
Department of Economics, Chungbuk National University, South Korea
ywgoo@cbnu.ac.kr

Katarzyna Anna Nawrot
Department of Regional and Global Studies, University of Warsaw, Committee of Future Studies, Polish Academy of Sciences, Poland
nawrotini@gmail.com
ORCID 0000-0002-0830-707X

Abstract. The relationship between housing and stock prices has traditionally been positive and stable. However, prior research suggests this relationship can vary significantly under certain economic conditions. For instance, Yoon (2018) identified a typical business cycle between housing and stock prices in the U.S. and U.K. during oil shocks, the IT bubble collapse, and the 2008 financial crisis. This study examines whether such standard asymmetric behaviour exists across G7 countries using the FIML Markov-switching model developed by Yoon and Nawrot (2022). Our findings indicate that housing and stock prices exhibit a shared business cycle during major economic disruptions, such as oil shocks, the global financial crisis, and the COVID-19 pandemic. Notably, these periods are characterised by heightened volatility in both markets. Conversely, no significant co-movement between housing and stock prices is observed during normal economic periods. These results underscore the importance of considering asymmetric relationships in analysing the interconnected dynamics of housing and stock markets, particularly during financial instability.

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1. INTRODUCTION

The relationship between housing and stock prices has long been a subject of interest in economics and finance, often assumed to be positive and linear. Seminal works supported this assumption, such as those by Case and Shiller (2003) and Case, Quigley, and Shiller (2005). However, subsequent studies have challenged this perspective by highlighting nonlinearity and segmentation between these markets. For example, Okunev and Wilson (1997) found that while real estate and equity markets appear segmented under linear tests, they are fractionally integrated when analysed with nonlinear models. Similarly, McMillan (2012) demonstrated a nonlinear long-run co-integration between housing and stock prices.

Historical evidence linking housing price fluctuations to major financial crises underscores the importance of understanding this relationship. Kindleberger (2000) observed that 21 out of 42 major financial crises from the early 1600s to the 1990s were driven by booming or slumping housing markets. Okunev, Wilson, and Zurbruegg (2000) identified a strong unidirectional influence from stock markets to real estate markets using nonlinear causality tests. This body of research highlights the need to move beyond linear approaches to understand better the dynamic and often asymmetric relationship between these markets.

Recent studies have further advanced this field. Yoon (2017) and Yoon and Nawrot (2022) identified a common asymmetric business cycle in housing prices across G7 countries. Additionally, Yoon (2018) found evidence of co-movement between housing and stock prices during specific economic disruptions, such as the oil shocks, the IT bubble collapse, and the 2008 financial crisis. These findings suggest that the relationship between housing and stock prices is nonlinear and contingent on economic conditions.

This study aims to explore the common asymmetric relationship between stock and real estate markets in G7 countries, particularly during periods of economic instability. To achieve this, we employ the FIML Markov-switching model developed by Yoon and Nawrot (2022), an extension of Hamilton's (1989) Markov-switching model designed to capture nonlinear dynamics in simultaneous equations.

Our findings reveal that housing and stock prices in G7 countries exhibit a shared business cycle during major economic disruptions, including the oil shocks, the global financial crisis, and the COVID-19 pandemic. These periods are marked by heightened volatility in both markets. Conversely, during normal periods, no significant co-movement is observed.

This paper is organised as follows: Section 2 offers a literature review. Section 3 discusses the methodology and data, focusing on the FIML Markov-switching model. Section 4 presents the empirical results and discusses the co-movement between the housing and stock markets. Finally, Section 5 concludes the study, emphasising its key contributions and implications.

2. LITERATURE REVIEW

The relationship between housing and stock prices has long been a research topic, often assumed to be positive and linear. Seminal works, such as those by Case and Shiller (2003) and Case, Quigley, and Shiller (2005), emphasise this assumption. However, the causality between these two markets has yielded mixed evidence. For instance, studies such as Kakes and Van den End (2004), Tsai et al. (2012), Shiller (2015), and

Irandoust (2021) support unidirectional causality from stock prices to housing prices. Conversely, McMillan (2012) finds evidence of unidirectional causality from housing prices to stock prices.

The nonlinear relationship between housing and stock markets is a key explanation for these discrepancies. Okunev and Wilson (1997) highlight the segmentation of real estate and equity markets when analysed with linear tests, while nonlinear models suggest fractional integration. Supporting this, McMillan (2012) found long-run nonlinear cointegration between housing and stock prices, and Yoon (2017), along with Yoon and Nawrot (2022), identified common asymmetric business cycles for G7 housing prices.

Historical perspectives provide additional context. Kindleberger (2000) noted that, between the early 1600s and the 1990s, housing price booms or slumps were implicated in 21 of the 42 major financial crises. Yoon (2018) observed common business cycles between housing and stock prices in the U.S. and U.K. during critical periods such as the oil shocks, the IT bubble collapse, and the 2008 financial crisis. Trojanek et al. (2023a) used recursive unit root tests and an error correction model to detect housing bubbles across two distinct cycles from 2000-2022. Furthermore, Yoon and Nawrot (2022) employed the FIML Markov-switching model to extend Hamilton's (1989) simultaneous equations framework, finding common international housing business cycles during the oil shock periods of the 1970s, the financial crisis in 2008 and the COVID-19 pandemic.

Due to the interconnectedness of global financial markets, the broader economic significance of housing market dynamics has gained attention. Kim and Renaud (2009) and Gupta et al. (2015) explored how monetary policy synchronisation influences housing markets. Additionally, Harris and Arku (2006), Goodhart and Hofmann (2007), and Leamer (2007, 2015) emphasise the critical role of housing markets in macroeconomic stability.

Numerous studies have linked housing prices to various economic factors. Case and Shiller (2003) and Kalra, Mihaljek, and Duenwald (2000) discuss the relationship between housing prices and broader economic conditions. Kindleberger (2000) reiterates the association between housing crises and economic instability, supported by Abraham and Hendershott (1996), Malpezzi (1999), and others, who highlight stable cointegration between housing prices and income. However, Gallin (2006) and Poterba (1991) question the stability of this relationship over time. Recent works, such as Igan and Loungani (2012), investigate global housing cycles, showing that housing price dynamics are often driven by income and demographic factors. Trojanek et al. (2023b) employed Bayesian Model Averaging to discover that financial factors like mortgage conditions were more influential than economic fundamentals in driving Polish house price dynamics. Regional studies, such as those by Chi-Wei et al. (2018) and Liow and Newell (2012), highlight cross-market relationships and volatility spillovers in Greater China and other regions.

Despite significant progress, limitations in existing research persist. Many studies focus on national-level housing markets, assuming homogeneity and neglecting regional or international differences (Kapingura & Sanusi, 2024). The impact and interconnectedness of the housing market and the stock market, while acknowledged, remain underexplored. Furthermore, traditional analytical techniques may introduce bias, and COVID-19-related disruptions have yet to be fully integrated into housing market analyses (Narayan, 2020a, 2020b; Liu, Wang, and Li, 2020; Padhan and Prabheesh, 2021).

The literature reveals complex and often conflicting relationships between housing and stock markets, influenced by nonlinear dynamics, regional variations, and macroeconomic factors. Future research should address gaps in understanding, particularly the interplay of monetary policy, regional heterogeneity, and the impact of global shocks such as the COVID-19 pandemic on housing business cycles.

3. METHODOLOGY

Specification of the model

To consistently estimate the parameters of the Markov-switching model within the framework of simultaneous equations, we consider the following FIML Markov-switching model:

$$YBs_t + Z\Gamma s_t = U_{St}\ ,\quad U_{St} \sim i.i.d.N(0, \Sigma_{St} \otimes I_T) \tag{1}$$

where **Y** is the T × M matrix of jointly dependent variables; $\boldsymbol{B_{St}}$ is an M × M matrix and is nonsingular; **Z** is the T × K matrix of predetermined variables; $\boldsymbol{\Gamma_{St}}$ is a K × M matrix and *rank*(Z) = K; and $\boldsymbol{U_{St}}$ is the T × M matrix of the structural disturbances of the system. Consequently, the model has M equations and T observations.

$$E(U_{St}^{'}U_{St}) = \begin{pmatrix} \sigma_{S1t,S1t}I_T & \sigma_{S1t,S2t}I_T & \cdots & \sigma_{S1t,SMt}I_T \\ \sigma_{S2t,S1t}I_T & \sigma_{S2t,S2t}I_T & \cdots & \sigma_{S2t,SMt}I_T \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{SMt,S1t}I_T & \sigma_{SMt,S2t}I_T & \cdots & \sigma_{SMt,SMt}I_T \end{pmatrix} = \Sigma_{St} \otimes I_T$$

$$p_{ij} = \Pr(S_t = j \mid S_{t-1} = i) \text{ with } \sum_{j=1}^{N} p_{ij} = 1 \text{ for all } i.$$

To derive the FIML Markov-switching model within the framework of simultaneous equations, we can obtain $\Pr(S_t = j \mid \psi_t)$ by applying the Hamilton Markov-switching estimator (1989) as follows:

Step 1: At the beginning of the t^{th} iteration, $\Pr(S_{t-1} = i \mid \psi_{t-1})$, $i = 0,1,\cdots,N$ is given, and we calculate

$$\Pr(S_t = j \mid \psi_{t-1}) = \sum_{i=1}^{N} \Pr(S_{t-1} = i, S_t = j \mid \psi_{t-1}) = \sum_{i=1}^{N} \Pr(S_t = j \mid S_{t-1} = i)\Pr(S_{t-1} = i \mid \psi_{t-1})$$

where $\Pr(S_t = j \mid S_{t-1} = i)$, $i = 0,1,\cdots,N$, $j = 0,1,\cdots,N$ are the transition probabilities.

Step 2: Consider the joint conditional density of y_t and unobserved variable $S_t = j$, which is the product of the conditional and marginal densities:

$$f(y_t, S_t = j \mid \psi_{t-1}) = f(y_t \mid S_t = j, \psi_{t-1})\Pr(S_t = j \mid \psi_{t-1})$$

from which the marginal density of y_t is obtained by:

$$f(y_t \mid \psi_{t-1}) = \sum_{j=1}^{N} f(y_t, S_t = j \mid \psi_{t-1}) = \sum_{j=1}^{N} f(y_t \mid S_t = j, \psi_{t-1})\Pr(S_t = j \mid \psi_{t-1})$$

where the conditional density $f(y_t \mid S_t = j, \psi_{t-1})$ is obtained from (2):

$$f(y_t \mid S_t = j, \psi_{t-1}) = (2\pi)^{-M/2}\det(\Sigma_{St})^{-1/2}\,|\det(Bs_t)|\cdot\exp(-\frac{1}{2}(y_tBs_t + z_t\Gamma s_t)\Sigma_{St}^{-1}(y_tBs_t + z_t\Gamma s_t)') \tag{2}$$

where $\Sigma_{St} = \frac{1}{T}(YBs_t + Z\Gamma s_t)'(YBs_t + Z\Gamma s_t)$, y_t is the t^{th} row of the **Y** matrix, z_t is the t^{th} row of the **Z** matrix, and $\boldsymbol{B_{St}}$ and $\boldsymbol{\Gamma_{St}}$ are obtained from (1).

Step 3: Once y_t is observed at the end of time *t*, we update the probability terms:

$$\Pr(S_t = j \mid \psi_t) = \Pr(S_t = j \mid \psi_{t-1}, y_t) = \frac{f(S_t = j, y_t \mid \psi_{t-1})}{f(y_t \mid \psi_{t-1})} = \frac{f(y_t \mid S_t = j, \psi_{t-1}) \Pr(S_t = j \mid \psi_{t-1})}{f(y_t \mid \psi_{t-1})}$$

As a byproduct of the filter in Step 2, we obtain the log likelihood function:

$$\ln L = \sum_{t=1}^{T} \ln f(y_t \mid \psi_{t-1})$$

which can be maximised concerning the model parameters.

Data

The quarterly Housing Price Index for the G7 countries was obtained from the BIS Residential Property Price database (2024). Total Share Prices for All Shares were also sourced from the FRED database (2024). The sample period spans from the second quarter of 1970 to the second quarter of 2024, providing 218 observations.

Test for Nonlinearity

We employed the nonparametric BDS test developed by Brock, Dechert, and Scheinkman (1996) to assess whether a nonlinear model is appropriate for the data. This test was applied to evaluate the suitability of a nonlinear model for the Housing Price Index. The BDS test results, presented in Table 1, indicate a rejection of the null hypothesis of linearity, suggesting the presence of nonlinear effects in the growth rate of the Housing Price Index.

Table 1

BDS Test for nonlinearity

US	Dimension		statistic (p-value)		
	epsilon	0.82	1.64	2.47	3.29
	2	31.9 (0.000)	20.2 (0.000)	17.0 (0.000)	16.1 (0.000)
	3	45.8 (0.000)	23.6 (0.000)	17.9 (0.000)	16.1 (0.000)
	4	68.8 (0.000)	27.0 (0.000)	18.3 (0.000)	15.5 (0.000)
UK	Dimension		statistic (p-value)		
	epsilon	1.38	2.77	4.16	5.55
	2	6.7 (0.000)	7.9 (0.000)	9.0 (0.000)	9.1 (0.000)
	3	7.6 (0.000)	8.2 (0.000)	9.5 (0.000)	9.6 (0.000)
	4	9.9 (0.000)	8.9 (0.000)	9.8 (0.000)	9.5 (0.000)
FR	Dimension		statistic (p-value)		
	epsilon	0.98	1.97	2.95	3.94
	2	10.3 (0.000)	6.8 (0.000)	5.8 (0.000)	6.1 (0.000)

	3	15.2 (0.000)	5.9 (0.000)	3.6 (0.000)	3.9 (0.000)
	4	27.8 (0.000)	9.0 (0.000)	4.4 (0.000)	4.6 (0.000)
DE	Dimension		statistic (p-value)		
	epsilon	0.62	1.25	1.88	2.51
	2	22.2 (0.000)	12.4 (0.000)	8.3 (0.000)	6.8 (0.000)
	3	35.2 (0.000)	15.0 (0.000)	8.8 (0.000)	6.4 (0.000)
	4	57.3 (0.000)	19.0 (0.000)	10.2 (0.000)	6.5 (0.000)
IT	Dimension		statistic (p-value)		
	epsilon	1.31	2.62	3.93	5.25
	2	18.7 (0.000)	17.3 (0.000)	15.1 (0.000)	14.7 (0.000)
	3	24.1 (0.000)	19.4 (0.000)	15.2 (0.000)	14.0 (0.000)
	4	31.9 (0.000)	22.0 (0.000)	15.5 (0.000)	13.2 (0.000)
CA	Dimension		statistic (p-value)		
	epsilon	1.47	2.95	4.43	5.90
	2	3.2 (0.001)	4.3 (0.000)	5.0 (0.000)	5.0 (0.000)
	3	2.5 (0.011)	4.2 (0.000)	5.1 (0.000)	5.2 (0.000)
	4	2.2 (0.027)	4.9 (0.000)	5.7 (0.000)	5.4 (0.000)
JP	Dimension		statistic (p-value)		
	epsilon	0.96	1.92	2.89	3.85
	2	38.1 (0.000)	22.6 (0.000)	18.5 (0.000)	17.7 (0.000)
	3	63.4 (0.000)	25.6 (0.000)	18.8 (0.000)	17.0 (0.000)
	4	105.9 (0.000)	28.6 (0.000)	18.5 (0.000)	16.1 (0.000)

Source: www.bis.org Database, Authors' estimates using R.

The BDS test results in Table 1 indicate the presence of nonlinear effects in the growth rate of the Housing Price Index in the G7 countries.

4. EMPIRICAL RESULTS AND DISCUSSION

To understand the co-movement of the housing and stock markets, let us consider the quarterly Housing Price Index and Stock Price Index in the G7 countries.

$$\Delta H_{us} = \alpha_{S_t} + \beta_{St} \Delta S_{us} + e_{St,us} \tag{3}$$

$$\Delta H_{uk} = \alpha_{S_t} + \beta_{St} \Delta S_{uk} + e_{St,uk} \tag{4}$$

$$\Delta H_{fr} = \alpha_{S_t} + \beta_{St} \Delta S_{fr} + e_{St,fr} \tag{5}$$

$$\Delta H_{de} = \alpha_{S_t} + \beta_{St}\Delta S_{de} + e_{St,de} \quad (6)$$

$$\Delta H_{it} = \alpha_{S_t} + \beta_{St}\Delta S_{it} + e_{St,it} \quad (7)$$

$$\Delta H_{ca} = \alpha_{S_t} + \beta_{St}\Delta S_{ca} + e_{St,ca} \quad (8)$$

$$\Delta H_{jp} = \alpha_{S_t} + \beta_{St}\Delta S_{jp} + e_{St,jp} \quad (9)$$

where ΔH is the log differenced housing price in the G7 countries. ΔS is the log differenced total share prices for all shares in the G7 countries.

$$\alpha_{St} = \alpha_0(1-S_t) + \alpha_1 S_t,\ \ \beta_{St} = \beta_0(1-S_t) + \beta_1 S_t,\ e_{St} = e_0(1-S_t) + e_1 S_t,\ S_t = 0, 1$$

Table 2

MLE of the FIML Markov-switching model (1970.II to 2024.II)

Parameters	
$\Delta H_{0,us} = 1.242 - 0.007\Delta S_{0,us}$, (0.123) (0.017)	$\sigma^2{}_{0,us} = 1.491$ (0.233)
$\Delta H_{1,us} = 1.675 + 0.093\Delta S_{1,us}$, (0.220) (0.026)	$\sigma^2{}_{1,us} = 3.818$ (0.636)
$\Delta H_{0,uk} = 1.615 - 0.051\Delta S_{0,uk}$, (0.187) (0.035)	$\sigma^2{}_{0,uk} = 3.699$ (0.492)
$\Delta H_{1,uk} = 2.550 + 0.052\Delta S_{1,uk}$, (0.387) (0.036)	$\sigma^2{}_{1,uk} = 12.49$ (1.915)
$\Delta H_{0,fr} = 0.970 - 0.033\Delta S_{0,fr}$, (0.165) (0.021)	$\sigma^2{}_{0,fr} = 3.045$ (0.381)
$\Delta H_{1,fr} = 2.160 + 0.035\Delta S_{1,fr}$, (0.216) (0.022)	$\sigma^2{}_{1,fr} = 3.909$ (0.596)
$\Delta H_{0,de} = 0.291 - 0.013\Delta S_{0,de}$, (0.099) (0.012)	$\sigma^2{}_{0,de} = 1.116$ (0.147)
$\Delta H_{1,de} = 1.379 + 0.029\Delta S_{1,de}$, (0.140) (0.016)	$\sigma^2{}_{1,de} = 1.460$ (0.226)
$\Delta H_{0,it} = 0.518 - 0.014\Delta S_{0,it}$, (0.117) (0.012)	$\sigma^2{}_{0,it} = 1.257$ (0.188)
$\Delta H_{1,it} = 3.577 + 0.096\Delta S_{1,it}$ (0.323) (0.028)	$\sigma^2{}_{1,it} = 8.589$ (1.340)
$\Delta H_{0,ca} = 1.216 + 0.065\Delta S_{0,ca}$, (0.217) (0.037)	$\sigma^2{}_{0,ca} = 4.536$ (0.633)
$\Delta H_{1,ca} = 1.960 + 0.119\Delta S_{1,ca}$, (0.403) (0.047)	$\sigma^2{}_{1,ca} = 13.36$ (2.052)
$\Delta H_{0,jp} = -0.163 + 0.023\Delta S_{0,jp}$, (0.109) (0.013)	$\sigma^2{}_{0,jp} = 1.261$ (0.164)
$\Delta H_{1,jp} = 1.857 + 0.067\Delta S_{1,jp}$, (0.236) (0.026)	$\sigma^2{}_{1,jp} = 4.499$ (0.695)

$Pr(S_t = 0|S_{t-1} = 0) = 0.96$, $Pr(S_t = 1|S_{t-1} = 1) = 0.94$

	(0.017)	(0.024)
Log Likelihood	-3021.63	

Note: Standard errors of the parameter's estimates are reported in parentheses.
Source: Authors' own calculations.

Table 2 presents the estimates from the FIML Markov-switching model using quarterly data from 1970: Q2 to 2024: Q2. The positive coefficient β_1 is significant, indicating a co-movement between G7 housing prices and stock prices during regime 1 periods. The variance is notably higher during regime 1 periods, as shown by $\sigma^2_1 > \sigma^2_0$, reflecting substantial volatility in these periods. Table 2 shows that housing prices exhibit a common business cycle with stock prices during regime 1 periods. However, the coefficient β_0 is small and not statistically significant, suggesting no co-movement between housing prices and stock prices during normal periods.

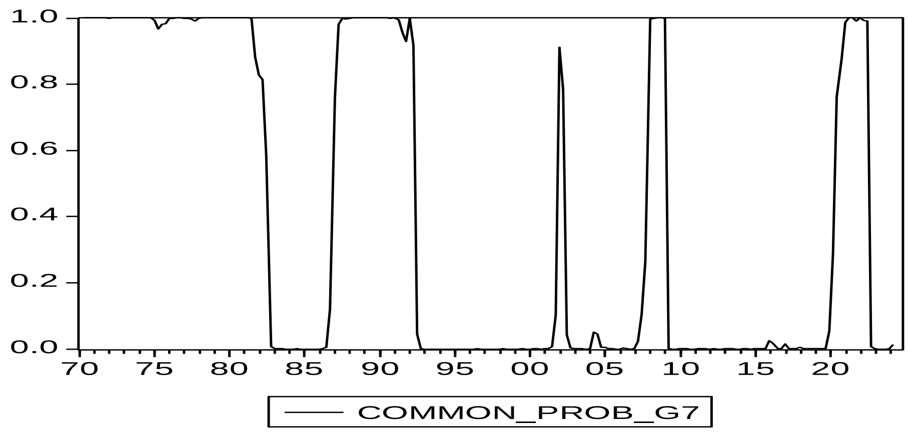

Figure 1. Common probabilities $\Pr(S_t = 1 | Y_T)$ in the G7 countries (1970: II to 2024: II)
Source: Authors' own calculations.

Figure 1 illustrates that the international common smoothed probabilities $\Pr(S_t = 1 | Y_T)$ align closely with periods of extremely large shocks, such as the oil shock, the financial crisis, and the pandemic during regime 1 periods. This suggests a co-movement between housing price collapses and stock market crashes during major economic shocks. Based on Figure 1, we conclude that housing prices in the G7 countries exhibit a common business cycle with stock prices during periods of significant economic disruptions.

5. CONCLUSION

This study investigates the dynamic relationship between housing and stock prices in the G7 countries, focusing on their behavior during economic shocks and normal conditions. Using a FIML Markov-switching model by Yoon and Nawrot (2022), we find evidence of a significant co-movement between housing prices and stock prices during major economic shocks periods, such as the oil crises, the financial crisis, and the COVID-19 pandemic. During these periods (regime 1), both markets display heightened volatility and synchronised movements, suggesting a shared vulnerability to global economic disruptions.

Conversely, our findings indicate no significant co-movement between housing prices and stock prices during normal periods (regime 0), when both markets appear to operate independently. This asymmetry underscores the relationship's nonlinear and regime-dependent nature, challenging the traditional assumption of a stable, linear association between these markets.

The results contribute to the literature on financial and real estate market linkages, highlighting the importance of accounting for nonlinear dynamics and regime shifts in economic analysis. These findings have significant implications for policymakers, investors, and economists, suggesting that crisis-period interventions should consider the interconnectedness of housing and stock markets. At the same time, strategies during stable periods may address these markets independently.

Future research could extend this analysis by exploring other regions or incorporating additional variables, such as interest rates or macroeconomic indicators, to understand the mechanisms driving these co-movements further.

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