DO HOUSE PRICES EFFECTIVELY HEDGE INFLATION IN G20 COUNTRIES?

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ABSTRACT

We examine the effectiveness of housing ownership as a hedge against inflation across G20 countries using the NARDL model. The results indicate that housing assets do not serve as effective inflation-hedging instruments, with South Korea being the sole exception for long-term purposes. While some countries demonstrate a positive association between CPI and house prices in the short term, the magnitude remains below one percent, rendering homeownership an ineffective inflation-hedging strategy in most cases. Additional analyses of major events and political changes indicate that COVID-19 and the democratization index are associated with negative effects on housing prices in certain countries. Overall, these findings imply that residential real estate should not be considered a reliable instrument for protecting household wealth against inflation.

Keywords: asymmetry effect, housing ownership, housing market, investment, real estate.
JEL Classification: C50, E31, R30.

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¿LOS PRECIOS DE LA VIVIENDA PROTEGEN EFICAZMENTE CONTRA LA INFLACIÓN EN LOS PAÍSES DEL G20?

RESUMEN

Analizamos la eficacia de la propiedad de la vivienda como cobertura contra la inflación en los países del G20 utilizando el modelo NARDL. Los resultados indican que los activos inmobiliarios no sirven como instrumentos eficaces de cobertura contra la inflación, con Corea del Sur como única excepción a largo plazo. Si bien algunos países muestran una asociación positiva entre el IPC y el precio de la vivienda a corto plazo, la magnitud sigue siendo inferior al uno por ciento, lo que hace que la propiedad de la vivienda sea una estrategia ineficaz de cobertura contra la inflación en la mayoría de los casos. Análisis adicionales de acontecimientos importantes y cambios políticos indican que la COVID-19 y el índice de democratización están asociados con efectos negativos en los precios de la vivienda en determinados países. En general, los resultados sugieren que los bienes inmuebles residenciales no deben considerarse un instrumento fiable para proteger el patrimonio de los hogares contra la inflación.

Palabras clave: efecto de asimetría, propiedad de la vivienda, mercado inmobiliario, inversión, sector inmobiliario.

Clasificación JEL: C50, E31, R30.

1. INTRODUCTION

Rising price levels are a persistent concern for economists, governments, investors, and citizens because they affect macroeconomic activity, investments, and purchasing power. Changes in the prices of consumer goods are captured by the Consumer Price Index (CPI), which is also reflects the actual value of the currency held by people. Individuals who invest in any instrument aim to protect the value of their assets from depreciation due to inflation and expect to earn capital gains in subsequent periods. Currently, there are various investment options available, including real estate (such as land, housing, and other properties), stocks, gold, and artwork (Salisu, Raheem, and Ndako, 2020; Valadkhani, Nguyen, and Chiah, 2022; Zhang Sun, and Wang, 2024).

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Housing —also known as residential real estate, whether owned or rented— is a fundamental necessity that provides essential services, including family dwellings, access to social networks, and a suitable living environment (McCabe, 2018). Unlike typical consumable goods, such as food or clothing, and unlike durable goods, such as cars or furniture, housing serves a unique dual purpose as both a consumption and an investment good (Felici and Fuerst, 2023; Stirling, Brill, and Purves, 2024). However, residential properties are not the only commodities exhibiting this dual nature. Many other commodities, including wheat, crude oil, cocoa, and coffee, also serve both consumption and investment purposes (Kang, Tang, and Wang, 2023). This dual functionality makes housing and similar commodities economically important for both household decision-making and broader market contexts.

From a financial perspective, housing plays multiple roles within household investment strategies. For individuals who own a single housing unit, it primarily functions as a residence and a store of wealth. Homeownership offers long-term economic benefits, including reducing housing expenditures through rent-free occupancy, mitigating the risk of future housing unaffordability, and providing potential capital gains through resale (Stirling, Brill, and Purves, 2024). In contrast, individuals who acquire multiple properties often use residential real estate as a source of passive income through rentals or as an instrument for portfolio diversification. These additional properties can serve as a hedge against inflation and have the potential to appreciate in value through future sales. This multifaceted approach to property ownership reflects the diverse economic roles that housing can play in personal financial planning and long-term wealth accumulation strategies.

The trend in house prices across eleven of G20 member countries (Figure 1) shows an upward trajectory over the past 18 years, albeit with varying rates and patterns. Similarly, the CPI, which reflects the price of consumer goods, has increased steadily over time. The similarity in these positive trend patterns raise the question of whether housing can effectively serve as a hedge against inflation. Numerous studies have examined this issue, including case studies conducted in various countries. However, the results have been inconclusive. Although housing can effectively hedge inflation under certain conditions in some countries, it does not prove effective in others. These mixed find-

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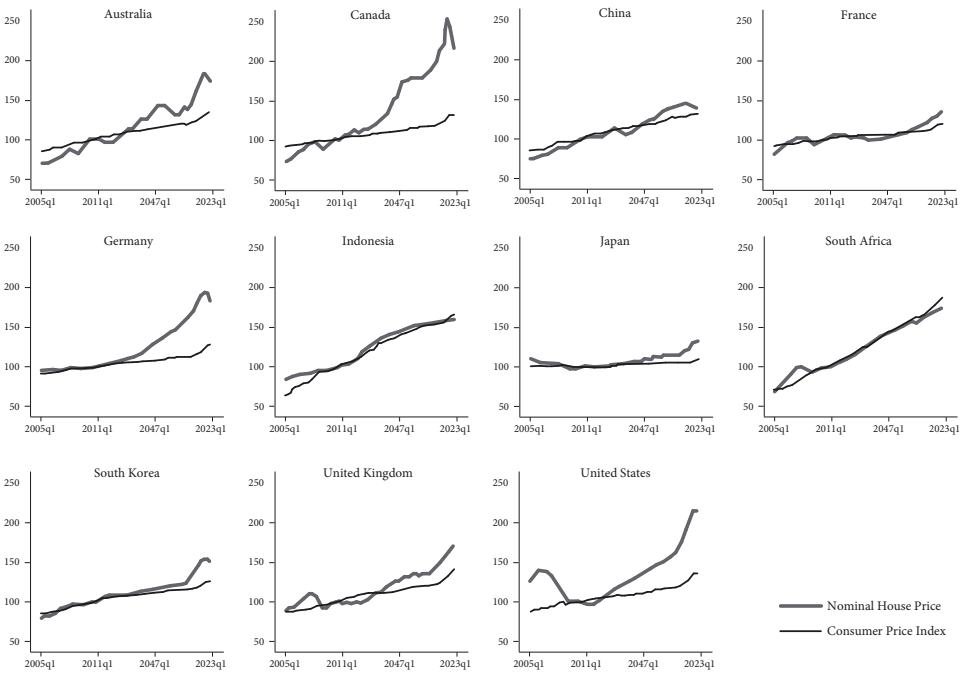
ings suggest that modelling for different countries and periods yields different results.

The main objective of our study is to reexamine the effectiveness of housing as an inflation hedge in selected G20 countries using current datasets with the same time span, while also investigate the influence of democratic performance among these countries. Previous studies have employed various methodologies, including linear and nonlinear Autoregressive Distributed Lag (ARDL) models, Vector Autoregression (VAR) with various modelling types, Vector Error Correction Models (VECM), and quantile regression. This study incorporates an additional approach to identify the presence of a moderator variable —COVID-19 shock.

Figure 1. Series of housing prices in eleven of G20 countries member



Note: of the total 19 G20 member countries, six were excluded due to data unavailability: Argentina, India, Mexico, Russia, Saudi Arabia, and Turkey. Additionally, two countries (Brazil and Italy) were excluded due to non-compliance with the fundamental assumptions of the Nonlinear Autoregressive Distributed Lag (NARDL) model.

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Our study contributes to the literature in two ways. First, this study investigates the effectiveness of housing as an inflation hedge using the democracy score as a moderator variable in conjunction with nonlinear ARDL. Indeed, using moderator variables does not mean that we modify the existing model. However, it can introduce a novel nuance, particularly given their infrequent use in the NARDL modelling context. Our approach is based on the findings of Desai, Olofsgård, and Yousef (2003) and Lei and Wisniewski (2025), who found an association between democracy and inflation and stock market returns. Nevertheless, we realize that the effectiveness of the democracy effect on the economy is still debated in existing literature. For instance, Vuletin *et al.* (2016) revealed that democracy does not cause economic growth, but Acemoglu *et al.* (2019) posited a positive relationship. Using democracy as a moderating variable is novel because this is the first study to examine its impact on hedging inflation in real estate assets.

Second, we analyzed several G20 member countries using an identical time range. Thus far, most research has concentrated on specific countries, such as the US (Christou *et al.*, 2018; Muckenhaupt, Hoesli, and Zhu, 2025) and China (Lee, 2021; Wu and Tidwell, 2015; Zhou and Clements, 2010). Relatively few studies have compared these results with those of numerous other countries. Muckenhaupt, Hoesli, and Zhu (2025) examined three developed countries, namely the UK, Japan, and Australia, and Lee (2021) analyzed three emerging market countries, namely China, India, and Russia.

For the remainder, this paper is organized as follows. Section 2 presents the hypothesis construction and provides a brief overview of the framework. Section 3 describes the methods. Section 4 describes of the datasets and preliminary results. Section 5 reports the empirical results including parameter stability checks. Finally, Section 6 concludes the study with a summary of the findings and limitations.

2. HYPOTHESIS CONSTRUCTION

The upward movement of housing prices can be explained through multiple channels, including construction costs, demographic changes, land scarcity, demand pressures, and speculation. The first channel involves constructing housing using materials and labour. An increase in

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these costs raises the price of building new houses, which increases the final price of newly constructed houses. Since existing homes are close substitutes for newly built ones, higher new house prices increase the replacement cost of older houses, leading to an overall rise in housing prices. However, empirical evidence suggests that construction costs alone are insufficient to explain overall housing prices, particularly in high-cost metropolitan areas (Potter and Syverson, 2025).

In addition, housing supply is constrained by limited land availability, while demographic trends such as population growth, urbanization, changes in fertility rates, and rising life expectancy influence housing demand. Together, these demographic forces and land scarcity tend to cause aggregate housing demand to outpace supply. As a result, housing prices continue to rise (Anenberg and Ringo, 2024; Francke and Korevaar, 2025; Gong and Yao, 2022; Jin *et al.*, 2024).

To formulate the hypothesis of this study, we refer to Figure 1 in the previous section. The figure shows that living costs tend to increase over time, as reflected by the CPI. Ideally, rising living costs would be offset by rising wages. In the context of asset ownership, such as residential real estate, housing prices are expected to adjust to inflation. When housing prices increase at the same rate as the CPI, homeownership can be considered an effective hedge against inflation because it preserves real wealth. However, when housing prices grow more slowly than the CPI, housing provides only partial protection and is less effective as a store of value. Conversely, when housing prices rise faster than the CPI, real estate ownership not only hedges against inflation, but also generates positive real returns in the form of capital gains.

Mathematically, the relationship between housing prices (HP) and inflation can be expressed as follows:

$$\ln HP_t = \alpha + \beta \ln CPI_t \qquad [1]$$

In this study, we are interested in the coefficient β, which reflects the inflation-hedging ability of housing assets. Since both *HP* and *CPI* tend to increase over time, we propose the following hypothesis:

H_1: in selected G20 countries, housing price exhibits short- and long-run inflation hedging ability.

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3. EMPIRICAL STRATEGY

Linear modelling approaches have been employed to describe house prices and inflation. Examples of this approach can be found in the works of Wu and Tidwell (2015), Lee (2021), and Fehrle (2023). The following models exhibit considerable diversity, encompassing cointegration, Granger causality, standard ARDL, and vector autoregressive techniques. However, these models are limited by their inability to account for asymmetrical responses. Previous studies, such as those by Yeap and Lean (2017) and Zhang, Sun, and Wang (2024), have identified the asymmetric effects of inflation on house prices and artwork prices. Since our study aims to determine whether positive and negative shifts in CPI have differential effects on house prices and seeks to ascertain whether both short-term and long-term effects of positive and negative shocks exist. Therefore, the NARDL model proposed by Shin, Yu, and Greenwood-Nimmo (2014) is a better fit for our study.

The NARDL model offers several advantages. First, it simplifies the analysis of potential relationships between linear and nonlinear cointegration variables. Second, it allows for the examination of the impact using short- and long-term scenarios. Third, the model enables the decomposition and estimation of the effects of positive and negative shocks from the independent variable on the dependent variable. Fourth, the model allows the independent and dependent variables to have different integration orders, specifically, a combination of orders 0 and 1. Fifth, the model generates asymmetric dynamic multiplier graphs. Additionally, the NARDL is robust and performs better in small samples (Hemrit and Benlagha, 2020). Therefore, this model is better and provides more benefits than standard cointegration methods, such as Engle-Granger cointegration and Johansen cointegration.

To examine the relationship between house prices and CPI, we extended equation [1] by employing an asymmetric long-run regression with negative and positive partial sum decompositions as follows:

$$\ln HP_{it} = \alpha_i + \beta_{1i}^{+} \ln CPI_{it}^{+} + \beta_{2i}^{-} \ln CPI_{it}^{-} + \gamma_{hi} X_{hit} + \varepsilon_{it} \qquad [2]$$

Where X is a control variable consisting of Gross Domestic Product (GDP), exchange rate, interest rate, total population, unemployment, and

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natural hazards (threats from wildfire and storm cyclone wind), and ε is an error term. Then β^+ and β^- are the long run asymmetric parameters of the primary independent variable. Coefficient γ is the relevant parameter for the control variables, and ε is an error term. Here, ln *CPI* is considered by incorporating the positive change ln CPI^+ and negative change ln CPI^-. Both represent positive and negative partial sums calculated as follows:

$$\ln CPI_{it}^{+} = \sum_{j=1}^{t} \Delta \ln CPI_{ij}^{+} = \sum_{j=1}^{t} \max(\Delta \ln CPI_{ij}, 0) \qquad [3]$$

and

$$\ln CPI_{it}^{-} = \sum_{j=1}^{t} \Delta \ln CPI_{ij}^{-} = \sum_{j=1}^{t} \min(\Delta \ln CPI_{ij}, 0) \qquad [4]$$

Following Shin, Yu, and Greenwood-Nimmo (2014), to obtain long- and short-term impacts, equation [2] is further rewritten in the error correction form as follows:

$$\begin{aligned} \Delta \ln HP_{it} = {} & \rho_i + \varphi_{1i} \ln HP_{i,t-1} + (\varphi_{2i}^{+} \ln CPI_{i,t-1}^{+} + \varphi_{3i}^{-} \ln CPI_{i,t-1}^{-}) \\ & + \left(\sum_{j=1}^{p-1} \delta_{1ij} \Delta \ln HP_{i,t-j} + \sum_{j=0}^{q-1} \delta_{2ij}^{+} \Delta \ln CPI_{i,t-j}^{+} \right. \\ & \left. + \sum_{j=0}^{q-1} \delta_{3ij}^{-} \Delta \ln CPI_{i,t-j}^{-} \right) + \omega_{hi} X_{hit} + (\varsigma_{hi} + \psi_{hi} \ln HP_{it}) D_{hit} \\ & + (\tau_i + \phi_i \ln HP_{it}) M_{it} + \varepsilon_{it} \end{aligned} \qquad [5]$$

The above equations were estimated to obtain the cointegrating relationships between the observed variables. The symbol Δ denotes the first difference in variables representing short-run estimates. Then *p*, *m*, and *n* represent the lag orders. $\beta_1^+ = -\varphi_2^+ / \varphi_1$ and $\beta_2^- = -\varphi_3^- / \varphi_1$ represent the long-run of an increase and decrease in ln *CPI* on the housing price, respectively. Moreover, $\sum_{j=0}^{m} \delta_{2j}^{+}$ captures the short-run impact of decline in ln *CPI* on house price, and $\sum_{j=0}^{n} \delta_{3j}^{-}$ measures the short-run of rising in ln *CPI* on house price. Further, *D* represents dummy variable with *D* = 1 referring to the time span from 2020Q1 to 2022Q4, then *M* is moderator variable consisting of the democracy score.

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4. DATA AND PRELIMINARY ANALYSIS

This study employs quarterly data from 2005Q1 to 2022Q4, which includes significant global economic disruptions, such as the COVID-19 pandemic. Regarding house price indices, there are two distinct types: nominal and real prices. Here, the nominal price index is more appropriate for our study because it includes sales of new and existing houses, aligning with the Residential Property Price Indices (RPPI) manual's recommendations. In contrast, the real house price index is calculated by dividing the nominal house price index by the consumer expenditure deflator for each country, which is derived from the OECD National Accounts Database. In this study, CPI is used as the independent variable. The datasets were obtained from the publicly accessible BIS Data Portal (https://data.bis.org). These two variables are presented in natural logarithmic form.

In addition, we employed seven additional control variables, including economic indicators such as GDP, exchange rates relative to the US dollar, interest rates, demographic factors such as total population and unemployment rate, and natural hazard exposure, including risks associated with wildfires and exposure to wind threats. We initially considered incorporating two additional control variables: the industrial production index and wages. However, due to incomplete data availability across countries in our sample, we excluded these variables from the model. Data for all control variables were obtained from three principal official data sources: the BIS Data Portal, the OECD Data Explorer, and the World Bank. All of the aforementioned variables were designated as deterministic variables in the Stata command, three of which were expressed as natural logarithms: GDP, exchange rate, and total population.

Furthermore, two additional variables were included as dummy and moderator variables. The period of the COVID-19 pandemic served as the dummy variable, based on the status declared by the World Health Organization (WHO) from January 2020 to May 2023 (Wise, 2023). Then, we used the democracy index obtained from the Our World in Data portal (Economist Intelligence Unit, 2024) as the moderator variable.

The summary statistics for the main interested variables are presented in Table 1. The table shows the descriptive statistics for the quarterly changes in house prices and inflation in eleven G20 countries. Of these

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Table 1. Descriptive statistics

Country	Nominal house prices changes				Inflation			
	Mean	Std. Dev	Skewness	Kurtosis	Mean	Std. Dev	Skewness	Kurtosis
Australia	1.316	2.249	0.101	2.460	0.660	0.596	–0.543	6.735
Canada	1.590	2.867	0.118	7.448	0.519	0.862	0.476	4.707
China	0.881	1.240	–0.331	2.816	0.601	0.954	–0.115	2.986
France	0.739	1.541	–0.224	3.633	0.375	0.526	1.057	5.628
Germany	0.906	1.352	–0.948	7.478	0.470	0.673	1.590	7.360
Indonesia	0.907	0.800	2.474	10.892	1.336	1.446	3.486	20.370
Japan	0.257	1.438	1.488	5.477	0.126	0.566	0.770	5.858
South Africa	1.337	1.374	0.470	4.395	1.380	0.865	0.375	3.299
South Korea	0.924	1.180	1.042	4.412	0.546	0.726	0.253	2.650
United Kingdom	0.945	2.015	–1.271	5.384	0.703	0.746	1.653	7.678
United States	0.791	2.170	–0.756	3.527	0.611	1.062	–0.680	6.575

countries, Australia, Canada, and South Africa experienced relatively high changes in house prices compared to the others. However, inflation shows a contrasting pattern, with South Africa and Indonesia having the highest inflation rates.

As mentioned in the Methods section, our study employed the NARDL model. Before investigating the existence of long- and short-run asymmetry, data stationarity should first be examined. In the NARDL, the data stationarity of the variables is likely a combination of I(0) and I(1). It is crucial to avoid I(2) stationarity in the model. There are numerous unit root tests in the economic literature. Here, we employed two tests: the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results are presented in Table 2 which shows that all the variables are stationary at I(1).

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Table 2. Stationarity checks with trend

Variable	ADF	PP	ADF	PP
Level				
	Australia		**Canada**	
Ln *HP*	−1.825	−2.642	−1.782	−2.187
Ln *CPI*	−1.058	−1.548	−1.122	−0.863
	China		**France**	
Ln *HP*	−0.800	−1.907	−1.603	−2.034
Ln *CPI*	−1.746	−1.756	−0.272	−0.991
	Germany		**Indonesia**	
Ln *HP*	−1.825	−1.778	0.459	−0.417
Ln *CPI*	1.001	0.376	−2.573	−2.642
	Japan		**South Africa**	
Ln *HP*	−1.222	−1.018	−4.005***	−3.584**
Ln *CPI*	−1.056	−1.268	−1.499	−1.523
	South Korea		**United Kingdom**	
Ln *HP*	−1.250	−1.917	−0.498	−1.115
Ln *CPI*	−1.573	−1.549	0.485	−0.765
	United States			
Ln *HP*	−0.010	−0.548		
Ln *CPI*	−1.016	−0.976		
First differences				
	Australia		**Canada**	
Ln *HP*	−3.546**	−3.763**	−5.088***	−4.910***
Ln *CPI*	−5.889***	−5.882***	−8.134***	−8.256***
	China		**France**	
Ln *HP*	−3.307*	−3.599**	−4.864***	−4.583***
Ln *CPI*	−9.743***	−9.576***	−5.789***	−5.715***
	Germany		**Indonesia**	
Ln HP	−3.410*	−3.367*	−3.923**	−3.849**
Ln *CPI*	−6.600***	−6.628***	−7.896***	−7.886***

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Table 2. Stationarity checks with trend (concluded)

Variable	ADF	PP	ADF	PP
First differences				
	Japan		South Africa	
Ln *HP*	−11.394***	−11.492***	−3.129*	−3.183*
Ln *CPI*	−7.497***	−7.488***	−9.366***	−9.300***
	South Korea		United Kingdom	
Ln *HP*	−3.048	−3.300*	−4.560***	−4.357***
Ln *CPI*	−11.278***	−10.785***	−5.079***	−5.248***
	United States			
Ln *HP*	−3.244*	−3.307*		
Ln *CPI*	−7.696***	−7.677***		

Note: 1/ the ADF and PP tests examine the null hypothesis, assuming the presence of a unit root against the alternative hypothesis of a stationary process. 2/ ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Furthermore, before proceeding with the NARDL model, we must first determine if there is any nonlinearity. For this purpose, we employed the Brock, Dechert, and Scheinkman (BDS) tests. As shown in Table 3, the results are statistically significant and reject the null hypothesis for independent and identically distributed (I.I.D.) data. This finding confirms the nonlinearity of the data series. Therefore, we proceeded with applying the NARDL approach.

5. EMPIRICAL RESULTS

5.1. NARDL estimation

Table 4 presents the NARDL estimation results for each country. Focusing on the short-run coefficient estimation results (marked with Δ), the table reveals associations between CPI and house prices in eleven countries with varying significance results. South Korea is the only country that demonstrating associations between both positive and negative CPI shocks and house prices, while China and France show associations only with

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Table 3. Nonlinearity test

Country	Variable	Dimension 2	Dimension 4	Dimension 6
Australia	Ln *HP*	25.612***	23.106***	22.108***
	Ln *CPI*	28.129***	26.216***	25.564***
Canada	Ln *HP*	27.409***	24.291***	22.977***
	Ln *CPI*	29.785***	25.946***	24.192***
China	Ln *HP*	30.837***	28.817***	28.504***
	Ln *CPI*	28.013***	27.526***	28.151***
France	Ln *HP*	14.955***	12.626***	11.177***
	Ln *CPI*	27.404***	24.577***	22.889***
Germany	Ln *HP*	17.400***	15.485***	14.529***
	Ln *CPI*	29.934***	26.109***	23.143***
Indonesia	Ln *HP*	32.294***	32.274***	34.274***
	Ln *CPI*	25.424***	24.095***	24.202***
Japan	Ln *HP*	10.220***	7.020***	5.563***
	Ln *CPI*	19.969***	18.804***	17.4537***
South Africa	Ln *HP*	27.427***	25.204***	24.560***
	Ln *CPI*	29.402***	27.494***	27.243***
South Korea	Ln *HP*	23.968***	21.029***	19.415***
	Ln *CPI*	23.710***	22.996***	23.474***
United Kingdom	Ln *HP*	22.017***	18.967***	17.258***
	Ln *CPI*	28.908***	26.513***	25.232***
United States	Ln *HP*	22.854***	18.512***	16.006***
	Ln *CPI*	29.158***	24.891***	22.627***

Note: ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

positive CPI shocks (first lag). Canada and South Africa show positive associations only in negative CPI shocks. However, these associations do not indicate that house prices effectively hedge against inflation. For example, house prices in Australia respond negatively to inflation. In contrast, in China, a positive CPI shock (first lag) is associated with rising house prices, though the coefficient is less than one.

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Table 4. NARDL estimation result

Variables	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	Australia				Canada			
$\Delta \text{Ln } CPI^{+}_{t}$	−0.139	−0.093	−0.143	−0.316	0.029	0.158	1.177**	1.302**
$\Delta \text{Ln } CPI^{+}_{t-1}$	−0.718	−0.691	0.380	−0.493	0.223	0.212	−1.001*	−0.841
$\Delta \text{Ln } CPI^{+}_{t-2}$	−1.628***	−1.626***	−1.583***	−1.631***	0.613	0.611	−0.664	−0.502
$\Delta \text{Ln } CPI^{+}_{t-3}$	−0.861	0.001	−0.137	0.011	0.986	0.985	0.045	0.057
$\Delta \text{Ln } CPI^{-}_{t}$	0.884	1.527*	1.897**	1.513**	2.589*	2.501*	3.018**	0.866
$\Delta \text{Ln } CPI^{-}_{t-1}$	−0.269	−0.083	1.105	0.391	2.919**	2.950**	2.983*	1.677
$\Delta \text{Ln } CPI^{-}_{t-2}$	−0.687	−0.989	0.082	−0.352	−0.726	−0.651	0.084	−0.911
$\Delta \text{Ln } CPI^{-}_{t-3}$	−0.878	−1.355	−0.919	−0.991	−1.242	−1.190	−0.684	−1.140
$\text{Ln } CPI^{+}$	1.668	2.177	0.588	1.083*	−6.218*	−6.259*	1.091	−2.939
$\text{Ln } CPI^{-}$	8.540	6.746	12.851*	19.125	−1.841	−1.425	−8.231	24.703
	China				France			
$\Delta \text{Ln } CPI^{+}_{t}$	0.154	0.212	0.151	0.180	−0.620*	−0.729**	−0.676**	−0.729**
$\Delta \text{Ln } CPI^{+}_{t-1}$	0.357*	0.441**	0.337*	0.227	0.932***	0.840**	0.991***	0.970***
$\Delta \text{Ln } CPI^{+}_{t-2}$	0.249	0.357	0.212	−0.006	0.321	0.192	0.313	0.451
$\Delta \text{Ln } CPI^{+}_{t-3}$	0.152	0.255	0.290	−0.104	0.456	−0.670	−0.600*	−0.600*
$\Delta \text{Ln } CPI^{-}_{t}$	−0.635	−0.618	−0.642	−0.526	1.047	1.137	0.243	−0.037
$\Delta \text{Ln } CPI^{-}_{t-1}$	−0.335	−0.413	−0.357	−0.155	5.117	5.130***	5.213***	4.180***
$\Delta \text{Ln } CPI^{-}_{t-2}$	−0.411	−0.501	−0.372	−0.108	1.582	1.515	1.414	0.623
$\Delta \text{Ln } CPI^{-}_{t-3}$	−0.178	−0.282	−0.304	−0.130	0.550	0.614	0.409	−0.253
$\text{Ln } CPI^{+}$	−1.228	−0.540	−1.271	0.735	−0.665	−1.218	−22.868	−26.878
$\text{Ln } CPI^{-}$	5.118	3.048	1.926	2.085	16.023	19.318	194.805	177.374
	Germany				Indonesia			
$\Delta \text{Ln } CPI^{+}_{t}$	−0.427	−0.410	−0.390	−0.342	−0.008	0.021	0.012	0.026
$\Delta \text{Ln } CPI^{+}_{t-1}$	0.126	0.059	0.078	0.072	0.142*	0.155*	0.124	0.075
$\Delta \text{Ln } CPI^{+}_{t-2}$	−0.004	−0.135	−0.126	−0.221	−0.027	−0.012	−0.025	−0.082
$\Delta \text{Ln } CPI^{+}_{t-3}$	−0.518	−0.769**	−0.758**	−0.835***	0.054	0.054	0.047	0.003
$\Delta \text{Ln } CPI^{-}_{t}$	−0.509	−0.719	−0.754	−0.637	−0.349	0.104	0.373	0.720
$\Delta \text{Ln } CPI^{-}_{t-1}$	2.488	1.810	1.806	2.069*	−2.544	−1.833	−1.688	−0.854
$\Delta \text{Ln } CPI^{-}_{t-2}$	0.610	0.487	0.525	1.035	−0.982	−0.378	−0.320	0.547
$\Delta \text{Ln } CPI^{-}_{t-3}$	0.812	1.137	1.153	1.385	−1.220	−0.807	−0.768	0.190
$\text{Ln } CPI^{+}$	−10.239	−5.754	−5.223	−3.332	26.268	−45.583	−0.847	1.075**
$\text{Ln } CPI^{-}$	91.176	54.957	50.174	44.706**	393.084	−804.553	−59.482	−21.701

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Table 4. NARDL estimation result (continued)

Variables	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
	Japan				South Africa			
$\Delta \text{Ln } CPI^{+}_{t}$	0.034	−0.287	−0.067	0.059	−0.134	−0.095	−0.090	−0.086
$\Delta \text{Ln } CPI^{+}_{t-1}$	0.370	−0.218	0.397	0.346	−0.258**	−0.241**	−0.173**	−0.203**
$\Delta \text{Ln } CPI^{+}_{t-2}$	0.202	−0.155	0.192	0.394	−0.099	−0.107	−0.032	−0.061
$\Delta \text{Ln } CPI^{+}_{t-3}$	0.277	−0.036	0.211	0.380	0.052	0.034	0.087	0.097
$\Delta \text{Ln } CPI^{-}_{t}$	−0.533	0.223	−0.409	0.514	−0.525	−0.036	−0.223	−1.853**
$\Delta \text{Ln } CPI^{-}_{t-1}$	0.486	0.536	0.289	0.587	1.454	1.019	0.186	−0.471
$\Delta \text{Ln } CPI^{-}_{t-2}$	0.636	0.945	0.368	0.331	3.689**	3.100**	2.252**	2.003**
$\Delta \text{Ln } CPI^{-}_{t-3}$	−0.520	−0.070	−0.831	−0.856	−0.353	−0.150	−0.099	−0.421
$\text{Ln } CPI^{+}$	3.933**	−3.446	5.295***	2.908***	−1.933	6.747	−1.585	0.768***
$\text{Ln } CPI^{-}$	−10.009***	9.961	−11.073**	−6.575***	−262.487	198.384	106.132	9.885
	South Korea				United Kingdom			
$\Delta \text{Ln } CPI^{+}_{t}$	0.452**	0.460**	0.374*	0.443**	0.589	0.481	0.184	0.215
$\Delta \text{Ln } CPI^{+}_{t-1}$	0.408*	0.394*	0.470**	0.436**	−0.152	−0.104	−0.434	−0.396
$\Delta \text{Ln } CPI^{+}_{t-2}$	0.124	0.081	0.161	−0.190	−0.205	0.215	−0.209	−0.203
$\Delta \text{Ln } CPI^{+}_{t-3}$	0.212	0.168	0.258	−0.066	0.039	0.294	0.060	0.071
$\Delta \text{Ln } CPI^{-}_{t}$	−0.653	−0.706	−0.579	−0.703	1.976	4.389	3.014	2.214
$\Delta \text{Ln } CPI^{-}_{t-1}$	0.923*	0.859	0.916*	0.982*	2.234	1.062	2.104	2.347
$\Delta \text{Ln } CPI^{-}_{t-2}$	1.114**	1.079**	1.103**	1.195**	−2.609	−4.136	−3.503	−3.026
$\Delta \text{Ln } CPI^{-}_{t-3}$	0.247	0.191	0.036	0.309	−1.649	−2.342	−2.334	−1.874
$\text{Ln } CPI^{+}$	1.429	1.598	0.884**	0.729***	0.503	−1.161	2.097	1.192
$\text{Ln } CPI^{-}$	5.998**	6.294**	3.843**	3.798***	11.137	−26.897	−81.359	8.007
	United States							
$\Delta \text{Ln } CPI^{+}_{t}$	0.021	0.056	−0.087	0.025				
$\Delta \text{Ln } CPI^{+}_{t-1}$	−0.092	0.058	−0.196	−0.139				
$\Delta \text{Ln } CPI^{+}_{t-2}$	−0.021	0.144	−0.107	−0.071				
$\Delta \text{Ln } CPI^{+}_{t-3}$	0.056	0.169	0.026	−0.037				
$\Delta \text{Ln } CPI^{-}_{t}$	0.115	0.055	0.366	0.132				
$\Delta \text{Ln } CPI^{-}_{t-1}$	−0.363	−0.314	−0.313	−0.258				
$\Delta \text{Ln } CPI^{-}_{t-2}$	−0.701**	−0.697**	−0.631**	−0.469*				
$\Delta \text{Ln } CPI^{-}_{t-3}$	−0.528*	−0.512*	−0.409	−0.247				
$\text{Ln } CPI^{+}$	−4.809	−8.559	−5.021	1.692				
$\text{Ln } CPI^{-}$	0.789	1.859	−7.035	7.023				

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Table 4. NARDL estimation result (concluded)

Variables	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Control variables								
GDP	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Exchange rate	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Interest rate	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Population density	Yes	Yes	No	No	Yes	Yes	No	No
Unemployment rate	Yes	Yes	No	No	Yes	Yes	No	No
Wildfire	Yes	No	No	No	Yes	No	No	No
Wind threat	Yes	No	No	No	Yes	No	No	No

Note: 1/ model 1 was designated as the benchmark. However, we adjusted for three countries (Japan, the UK, and the US) based on parameter stability checks (see Figure 3). 2/ ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

In the short-run, Canada is the only country that shows a positive association between negative CPI shocks and house prices. However, this result is considered unreliable for several reasons. First, the association was significant only when the population variable was excluded as a control variable, despite the control variable being significant at the 1 percent alpha level. Second, although no multicollinearity issues were identified, inconsistent behavior was observed in the short- and long-run parameters, with one being significant while the other was not. Third, comparing the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the adjusted R-squared values indicates that including the population as a control variable leads to lower AIC and BIC values and a higher adjusted R-squared value. Therefore, we conclude that short-run CPI parameters (positive shocks) do not exist in Canada.

For the positive CPI shocks in the short-run, only France and South Korea demonstrated the strongest association with house price increases. In South Korea, one percent inflation is associated with a 0.4 percent increase in house prices (see $\Delta \ln CPI_t^+$ and $\Delta \ln CPI_{t-1}^+$), while house prices increase by 1.1 to 1.2 percent during deflation (see $\Delta \ln CPI_{t-1}^-$ and $\Delta \ln CPI_{t-2}^-$). In France, house prices are projected to increase by 0.1

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to 0.3 percent. This is due to a counterbalancing phenomenon between the two parameters (see $\Delta \ln CPI_t^+$ and $\Delta \ln CPI_{t-1}^+$).

An ideal inflation hedge for housing exhibits two key characteristics. First, during inflationary periods, house prices should appreciate at a rate equal to or greater than the inflation rate. Second, during deflationary periods (negative shocks), house prices should either continue to appreciate or decline at a rate lower than the deflation rate. South Africa and South Korea partially fulfill these conditions. In these countries, the NARDL short-run parameter reveals a significant positive value higher than one during negative shocks. This means that when the CPI decreases by one percent during deflation, house prices increase by more than one percent. However, this favorable response is not observed during positive shocks or inflationary periods. Consequently, short-run parameter indicates that housing ownership in these countries does not serve as an effective hedge against inflation.

From the same table, we can identify that CPI shocks are significantly associated with long-term housing prices only in South Korea. In South Korea, one percent of negative CPI shock is associated with 3.8-6.0 percent increase in house prices. The long-term model for Japan yields intriguing results, with housing prices outpace inflation during inflationary periods, but experience a sharp decline of 6.5-11 percent during deflationary phases. Given the four prolonged deflationary cycles in Japan in the past two decades (2005-2008, 2009-2013, 2015-2017, and 2020-2022), using real estate as an inflation hedge in Japan carries a high risk and requires careful consideration to avoid loss of asset value.

In summary, we expected to find a positive correlation between the CPI and house prices. However, our empirical findings challenge this common expectation. Inflation-hedging ability was observed only in South Korea and was limited to specific long-run model specifications. Furthermore, our model produced unexpected results in several countries, particularly Australia, Germany, and South Africa, where short-term inflation increases were associated with house price declines. Conversely, Indonesia, the UK, and the US showed no relationship between CPI increases and house prices in the short or long term. Then the model for Japan indicated that there were no significant short-run parameters.

While our findings contradict to some previous studies —see Leung (2010), Taderera and Akinsomi (2020), and Muckenhaupt, Hoesli, and

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Zhu (2025)— our findings align with other previous studies. For instance, Fehrle (2023) found that the housing return rate in Germany is an outlier with a negative inflation relationship estimations. Our results partially corroborate those of Ma and Liu (2010), who found no short-term correlation between house prices and consumer price indices, though they identified long-term relationships in most cities. Similarly, our South African results align with Lotz and Gupta's (2013). Again, these results highlight the importance of considering country-specific factors when analysing the relationship between inflation and housing markets.

5.2. Diagnostic checks

For transparency, we present the diagnostic check results for the benchmark model in Table 5. To evaluate the model fit, we used the coefficient of determination, represented by the R-squared and adjusted R-squared values. We also used the Portmanteau test to check for non-autocorrelation, the Breusch-Pagan test to check for homoscedasticity, and the Jarque-Bera test to check for normality. The Ramsey RESET test was then used to determine whether the model was correctly specified. In general, the diagnostic results reveal that the models for Canada, Japan, and South Korea violate multiple assumptions. In contrast, certain models for China satisfy all assumptions.

5.3. Identifying dummy and moderator variables

Housing price movements are influenced by various indicators, not just one variable like the CPI. Multiple studies have examined the impact of various crises on housing prices. For instance, Rafiq (2022) found that after World War II, house prices became more vulnerable to crises, with financial recessions causing the most significant decreases. More recently, the impacts of the COVID-19 pandemic on housing markets have been significant. Hansen *et al.* (2024) found evidence of housing prices bubbles in the US during the pandemic, with significant regional differences. In contrast, Ramani and Bloom (2021) reported a decline in rents and property values in high-density areas and central business districts in the US when the pandemic began. Together, these findings highlight the heterogeneous nature of housing market responses to multiple crises.

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Table 5. Diagnostic checks

Statistics	Australia	Canada	China	France	Germany	Indonesia
R^2	0.822	0.675	0.710	0.769	0.649	0.622
Adj. R^2	0.740	0.526	0.577	0.663	0.489	0.449
Portmanteau test	45.040*	20.980	27.170	106.30***	30.070	38.460
Breusch/Pagan test	0.273	11.760***	2.615	1.416	1.910	63.460***
Ramsey RESET	0.579	6.725***	2.113	2.077	5.361***	1.035
Jarque-Bera test	0.484	13.270***	1.263	1.154	0.838	145.00***
	Japan	**South Africa**	**South Korea**	**United Kingdom**	**United States**	
R^2	0.608	0.898	0.783	0.684	0.860	
Adj. R^2	0.441	0.851	0.684	0.567	0.801	
Portmanteau test	33.700	34.540	20.450	37.860	27.300	
Breusch/Pagan test	12.420***	0.136	10.310***	0.007	0.012	
Ramsey RESET	3.115**	2.147	5.235***	0.530	1.813	
Jarque-Bera test	14.530***	5.869*	25.370***	11.390***	6.027**	

Note: 1/ the null hypothesis for each test was as follows: There was no autocorrelation (Portmanteau test), the residuals were distributed equally at each level/homoscedastic (Breusch/Pagan test), the model was correctly specified (Ramsey RESET), and the dataset followed a normal distribution (Jarque-Bera test). 2/ ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

Table 6. Moderator and dummy variable checking

Variables	Australia	Canada	China	France	Germany	Indonesia
COVID	–1.581	–0.243	1.019	–1.632	2.549	0.348
COVID × Ln *CPI*	0.331	0.046	–0.211	0.356	–0.539	–0.071
Democracy	–2.007	–2.440	–1.307	0.588	1.470	0.658*
Democracy × Ln *CPI*	0.420	0.482	0.272	–0.134	–0.309	–0.133*
	Japan	**South Africa**	**South Korea**	**United Kingdom**	**United States**	
COVID	2.406	0.775*	1.679	–1.830**	1.323	
COVID × Ln *CPI*	–0.519	–0.154*	–0.359	0.384**	–0.277	
Democracy	–2.301	0.392*	–2.891***	2.456***	–0.386	
Democracy × Ln *CPI*	0.503	–0.076*	0.622***	–0.517***	0.058	

Note: 1/ this estimation based on the benchmark model specification and includes the 2008 financial crisis as an additional control variable. 2/ ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

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In this study, we hypothesize that the pandemic has a negative impact on property valuations and prices. Our modelling results using dummies (see Table 6) reveal that this pandemic influenced house prices in four countries, though the effects varied. Germany and South Africa experienced negative CPI effects, while France and the UK saw positive impacts.

Furthermore, we estimated the impact of democratization on house prices in eleven countries. We hypothesized that democratic performance acts as a moderating variable that influences the relationship between CPI and house prices. Initially, our datasets revealed three distinct categories based on democracy scores. China had the lowest average score of 2.87. Indonesia and South Africa fell into the medium-democracy category with scores ranging from 6.5 to 7.9. The remaining countries had high democracy scores, exceeding 8.

Our estimation results are presented in Table 6 and reveal some interesting findings. First, democratic performance does not appear to influence housing prices in China. As a country governed by a communist ideology, the Chinese government exerts strong control over its economic policies. However, this does not mean that market responses always align with policy directives. Recent studies by Huang, Gan, and Song (2024) and Zhao *et al.* (2024) found that cancelling policies that restricted house purchases increased housing transactions in China, though the impact on house prices was unclear or negligible.

Second, democratic performance through the CPI shows varying associations with housing prices across countries. In two developed Asian nations (Japan and South Korea), this association was positive. However, in Indonesia, South Africa, and the UK, democratic performance was negatively associated with housing prices. The negative association in Indonesia and South Africa may be attributed to political uncertainty, as these two developing countries are still in the process of democratization —as indicated by their medium democratic performance scores. Political uncertainty typically has an adverse effect on housing prices (Nguyen and Alert, 2023). Nevertheless, we lack a more detailed explanation for our finding that democracy appears to make the CPI negatively associated with house prices in the UK. The literature suggests that there are significant variations in UK house price movements around House of Commons elections. House prices perform better in the year before elections than in the year after (Aha, Higgins, and Lee, 2023). This observation provides

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some context for the complex interplay between democratic processes and housing market dynamics. Further research is needed to elucidate the mechanisms underlying this relationship.

5.4. Asymmetric dynamic effect

Moreover, this study examines the dynamic asymmetric adjustments of house prices in response to CPI variations using the cumulative dynamic multipliers (see Figure 2). The asymmetric curves illustrate the combination of dynamic multipliers associated with positive (dashed short line) and negative (dashed long line) changes, describing how house prices adjust to positive and negative CPI shocks over time, with asymmetry represented by the solid line. The shaded areas are bootstrapped with 95 percent confidence intervals (lower and upper bounds) for asymmetry. Significant asymmetric effects are observed when the zero line falls outside the confidence interval, as shown in Figures 2(a), 2(b), 2(c), 2(e), 2(f), 2(h), 2(j), and 2(k). These visual representations complement the results in Table 6, aiding in the understanding of the asymmetrical associations between CPI changes and house prices across countries.

Figure 2. House price and CPI dynamic multiplier

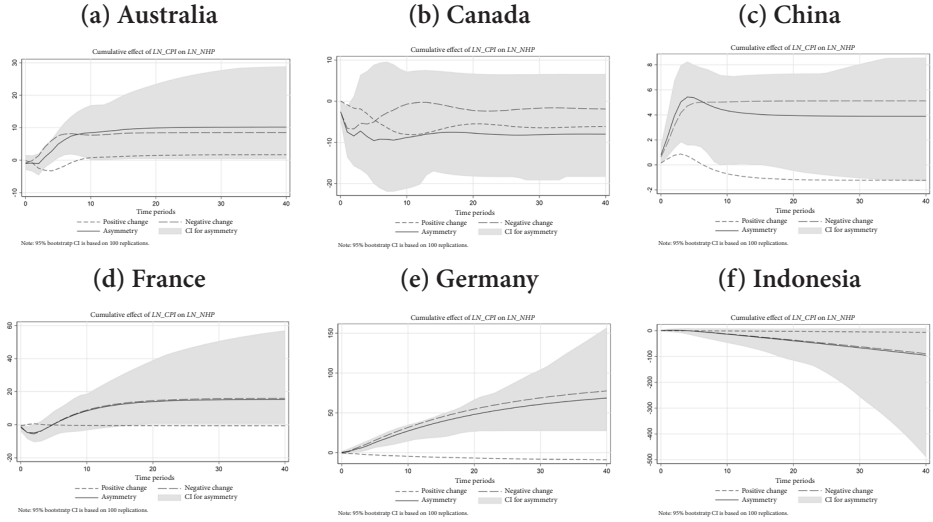

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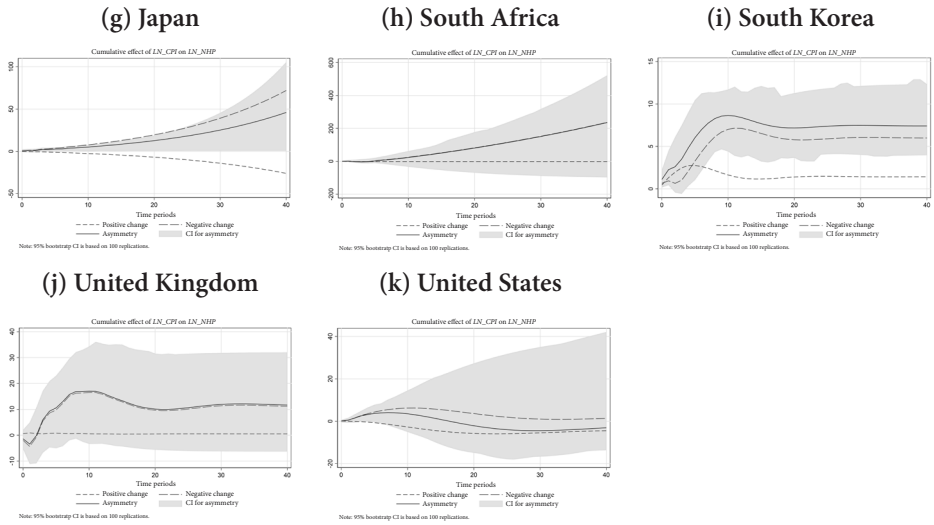
Figure 2. House price and CPI dynamic multiplier (concluded)



In South Korea, the short-run parameters of both positive and negative shocks are significant and positive in our model. This results in upward-sloping short and long dashed lines on the graph. The black solid line, which represents the sum of the two shock types, is higher due to the positive parameters of both shocks. However, Table 5 shows no short-run asymmetry, as the zero lines are covered by the grey shaded area. After 20 quarters, the cumulative dynamic multiplier converges to the long-run coefficient, with δ_i equal to φ_i. Although only negative shocks exhibit a significant long-run coefficient, the asymmetry effect remains substantial, causing the shaded grey area to no longer cover the zero line. The shaded grey area above the zero line is explained by a positive asymmetry effect.

Similar to Canada, the results for this country reveal no asymmetry effect in either the short or long run. However, some short-run adjustment paths were observed, and two parameters (negative shock) were significant at the 10 percent level (Table 4). This indicates that increases and decreases in the CPI have an equal impact on the speed of house price adjustments in the short term. The long-run coefficients exhibit a similar pattern, with significant positive shock parameters but no asymmetry effect. Both the short- and long-run coefficients are clearly visible in the

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grey shaded area, which includes the zero line. This further supports the lack of asymmetry in the association between the CPI and house prices.

Overall, these figures reveal no general pattern across countries, as each model exhibits distinct characteristics. The graphical analysis of the benchmark model (Model 1) indicates that most models for each country exhibit no asymmetry. Only France (short-run), Japan (long-run), and South Korea (long-run) display different impacts between negative and positive shocks.

5.5. Parameter stability

To ensure the reliability of our findings, the estimated parameters were evaluated using the Cumulative Sum (CUSUM) approach at the five percent significance level, as illustrated in Figure 3. An additional assessment was conducted to determine the stability of these parameters in Model 1, which was used as a benchmark. In this model, all control variables were included into the modelling process. Preliminary results showed that eight models were stable, two were unstable, and one could not display a stability test graph. For the two unstable models (Japan and the UK), we identified the causes of parameter instability: the population variable for Japan and the exchange rate, interest rate, and population for the UK. Concurrently, the CUSUM graph for the US could not be displayed due to the use of the exchange rate as a control variable. In our study, we compared the currency of each country to the US dollar. Consequently, the exchange rate value for the US is one, as it is being compared with itself. After eliminating these problematic controls across the three countries, the results showed that the model was stable, as shown by the estimated line fell within the boundaries of the critical lines (the upper and lower bounds).

Figure 3. Parameter stability checking

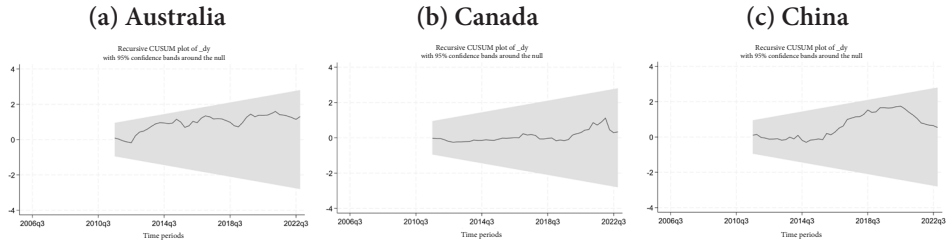

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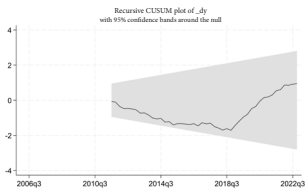
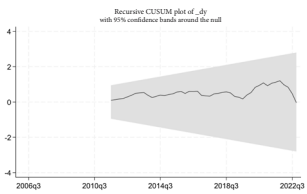
Figure 3. Parameter stability checking (concluded)

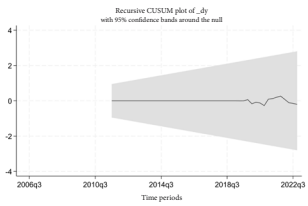
(d) France



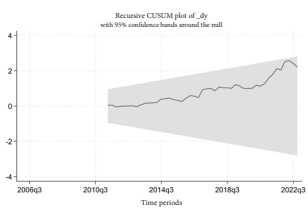
(e) Germany



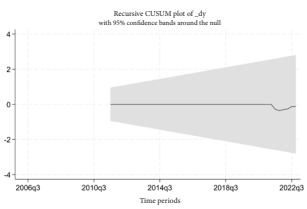
(f) Indonesia



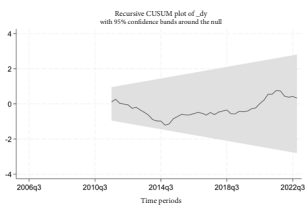
(g) Japan



(h) South Africa

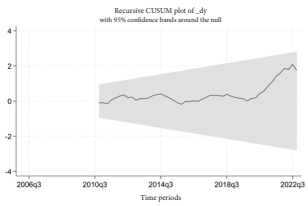


(i) South Korea



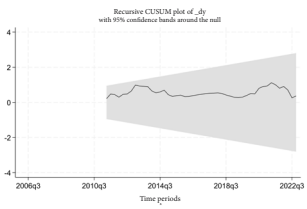
Note: to make it more stable, we dropped the population from the control variable.

(j) United Kingdom



Note: to enhance stability, we eliminated three control variables: the exchange rate, interest rate, and population.

(k) United States



Note: to make the graph appear, we dropped one control variable: the exchange rate.

6. CONCLUSION

The role of residential property ownership has evolved from primarily providing basic shelter to also functioning as an investment asset. Over the past two decades, housing prices have shown an increasing trend, suggesting a possible association with the overall increase in consumer goods prices, as reflected in the consumer price index. Therefore, this study examines whether house prices are associated with asymmetric shocks from consumers prices. This study contributes to the existing body of knowledge by using the democracy score as a moderator variable

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alongside a nonlinear ARDL, examining the impact of health crises, and conducting a comparative analysis across multiple countries, particularly G20 members.

Our empirical findings indicate that —with the exception of South Korea— homeownership assets generally do not effectively hedge against inflation in the long term. While some countries exhibit a positive correlation between CPI and house price increases in the short term, the parameters derived from various model specifications reveal that the overall increase remains below one percent. This makes homeownership assets infeasible as inflation-hedging tools for most of the countries studied.

We also conducted additional analyses to examine the impact of major events and political changes on housing assets as inflation hedges. Our findings reveal that the COVID-19 pandemic negatively affected house prices in Germany and South Africa but positively in France and the UK. Interestingly, democratization was associated with negative effects on house prices in Indonesia, South Africa, and the UK, possibly due to political uncertainty. These results highlight the diverse impact of global crises and political shifts on housing markets across countries, illustrating the intricate relationship between economic, health, and political factors in determining the effectiveness of housing as an inflation hedge.

This study acknowledges several limitations that should be addressed in future research. While the use of macro-level data enables cross-country comparisons and provides broader insights, it limits the depth of analysis that could be achieved by using micro-level data from a single country. One notable shortcoming is the limited scope for detailed heterogeneity analysis. This part has been explored more extensively in country-specific studies, particularly those focusing on the US and China. To expand the breadth and depth of heterogeneity analyses in this field, we encourage future researchers to focus on less-studied G20 countries, such as Indonesia and South Africa. ◄

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