# Testing the relationship between housing prices and inflation in the OECD Countries

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## Abstract

### Purpose

This study aims to construct alternative models to establish the dynamic nexus between inflation and housing prices by estimating the short- and long-run relationship between housing prices and inflation for 15 OECD countries from 1980Q1 to 2022Q4. Furthermore, we examined this association using the core & headline inflation and price-income & price-rent ratios as proxies for inflation and housing prices, respectively.

### Design/methodology/approach

We employ the panel Autoregressive Distributed Lag (PARDL) technique to examine the nexus between housing prices and inflation to capture the distinct characteristics of the sample countries, estimate various short-run and long-run dynamics cum separate analyses for turbulent and calm periods in the relationship between housing prices and inflation.

### Findings

Changes in housing prices have a greater impact on core inflation than headline inflation. Overall, we establish a positive (negative) relationship between housing prices and core inflation in the long run (short run) based on alternative proxies of housing prices. However, this connection tends to be less significant for headline inflation and episodic over smaller samples as it seems stronger during calm periods than turbulent ones.

### Originality

The authors are the first to examine the association between housing prices and inflation by demonstrating how these variables behave during calm and turbulent periods.


**Keywords: Housing Prices, Long Panels, Inflation, Global Financial Crisis.**
**JEL Codes: R21, C23, E31, G01.**

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## 1. Introduction

Housing prices and their associated dynamics usually significantly affect household decisions about consumption, investment, and the aggregate economy. Essentially, the global financial crisis of 2007, with its attendant consequences on the international financial markets, emanated from the subprime mortgage crisis. The global financial crisis underscored the significance of the nexus between housing prices and the financial markets (Korkmaz, 2019) on the one hand and housing prices and other macroeconomic fundamentals on the other hand (Zhang *et al*., 2016). Frequent changes in the price of houses portend a serious threat to financial and price stability because housing is a significant asset in terms of collateral and credit guarantee (İslamoğlu and Nazlioğlu, 2019). The use of asset values, particularly housing, to evaluate consumer price inflation has a theoretical basis in the literature (see Goodhart and Hofmann, 2000; Zhang, 2013). More collateral value and borrowing are expected to result from higher asset prices (see Bernanke and Gertler, 2000). As a result, consumer price inflation may be significantly impacted by changes in the housing market (Zhang, 2013). At steady interest rates, greater asset prices can encourage bank lending and money growth if expectations of increased future activity and profits are guaranteed. The relevant real interest rate for borrowers planning to purchase such assets decreases to the extent that rising asset values inspire expectations of future asset price increases and capital gains. In practice, it appears that there are frequent instances, in both the housing and equity markets, where expectations of abnormal future capital gains seem, at least, to be driving bank lending, monetary growth, and significant portions of real expenditures, even though in theory, except in the case of a bubble, asset prices would constantly meet up with a level that equals expected returns, adjusted for risk, on all assets (see Goodhart and Hofmann, 2000).

Similar to the foregoing, appreciation of property and the need to secure returns on investment usually prompt investors to diversify their portfolio to include real estate assets. This tends to push up housing prices and, ultimately, inflation (see Tang *et al*., 2019). To Meltzer (1995), real capital asset prices, such as housing, are an intermediate variable between monetary expansion and consumer price inflation. This monetarist theory underlines the possibility that any increase in housing prices could ultimately increase consumer prices. Essentially, a spike in the demand for money due to an increase in net household wealth resulting from a sharp increase in housing prices could impact consumer price inflation positively (Zhang, 2013).

Furthermore, housing price is usually included in the composition of the Consumer Price Index (CPI), which measures the prices of various regularly used household goods and services; a small increase in rent and house prices can theoretically impact inflation (see Cournède, 2005). Housing accounts for about a third of the CPI inflation in the US and 40 per cent of the basket for core CPI, which does not include the volatile food and energy components (Bernstein, *et al.*, 2021). Aside from the detrimental impact of rising house prices on renters' cost of living and that of potential homeowners who give up any wealth effects, rising house prices also impact the user cost of capital associated with home ownership. Existing owner-occupiers who see a rise in wealth during a residential real estate boom must also contend with a greater cost of living as they face a higher opportunity cost of capital for the same volume of housing services (Cournède, 2005).

Similar to the consequences of the global financial crisis on the housing market (see Murphy, 2011), the housing market, in recent times, has experienced unprecedented price hikes due to shocks brought on by the COVID-19 pandemic (Bernstein *et al*., 2021). Specifically, inflation is one of the havoc the COVID-19 pandemic left the world to grapple with, and the increase in central bank policy rates to stem this tide has continued to impact housing prices greatly. For instance, the average home sales price crossed the $400,000 line for the first time in 2023, reaching $410,200, the second-highest price ever recorded. It is now on track to surpass the previous record high witnessed in June 2022 at $413,800. Consequently, the monthly home sales dropped by 3.3 per cent, with all four major U.S. regions posting year-on-year sales declines (see Rothstein and Jennings, 2023). Örsal (2014) puts this in context for the OECD economies when he contends that real GDP per capita, real interest rate, and global shocks are the primary factors influencing real house prices in OECD countries. Housing prices have fluctuated dramatically over the past few decades in many OECD countries, with a significant upsurge occurring in the 1990s and the early half of the 2000s. This trend has been particularly evident in countries such as Denmark, Ireland, Netherlands, Spain, Sweden, the United Kingdom, and the United States (Engsted, Hviid and Pedersen, 2016). Engsted *et al*. (2016) attribute these changes in housing prices to either changes in economic fundamentals or speculative bubbles (or both). Similarly, the harmonized index of consumer price (HICP) services inflation in the euro area, which includes all of its countries as OECD members, has decreased in the past due to a decline in home rental inflation (see European Central Bank [ECB], 2016). Quantitatively, 15 per cent of the euro area's HICP services basket comprises the HICP item "actual rentals for housing," which has an annual inflation rate generally steadier than the whole services basket (ECB, 2016).

Empirical evidence of a close connection between housing prices and inflation also abounds, and that the housing market can provide a hedge during inflation (Le Moigne and La, 2008; Kuan and Lim, 2015; Wurstbauer and Schäfers, 2015; Salisu *et al*., 2020). A plethora of other studies have demonstrated by analysing the factors that influence the level and volatility in real house prices (Andrews, 2010), the nexus between housing prices and some macroeconomic fundamentals such as inflation, money, output and interest rate (see Cournède, 2005; Demary, 2009, 2010; Zhang, 2013; Breitenfellner *et al*., 2015; Kuang and Liu, 2015; Kishor and Marfatia, 2017, 2018; Tripathi, 2019; Fuller *et al*., 2020). To the best of our knowledge, none of these (or other) studies have isolated the impact of housing prices on inflation from a broader perspective, thereby making this study the first to offer empirical evidence in this respect. For instance, while Kishor and Marfatia (2017) show evidence of a dynamic relationship among house prices, income and interest rates in fifteen OECD countries, Zhang (2013) shows the process through which money growth translates to higher housing prices and then increases consumer goods prices, albeit in China. Examining the nexus in the same country but focusing on different cities that make the economy, Kuang and Lim (2015) find an asymmetric relationship between the two variables. Consequently, one of the major contributions of this paper is that it offers panel data evidence for the influence of housing prices on inflation in OECD countries. Thus, some meaningful generalizations can be drawn from the analyses that policymakers at the regional level, such as the ECB, can find useful when taking policy actions to stabilize prices.

Furthermore, the nexus between housing prices and inflation is analyzed using heterogeneous panel regression models, which explicitly account for heterogeneous structural factors in errors (Kien and Hashimoto, 2005). Another attraction to this technique of analysis is that it offers both long-run and short-run dynamics to economic relationships, as some (economic relationships) respond differently to the two periods. Foretelling our results, we show that housing prices have an increasing impact on inflation in the OECD countries in both the short- and long-run periods. The significance of this study rests in its policy implications, particularly for those responsible for controlling inflation. Since contemporaneous changes in the CPI are sometimes consistent with the general pattern of house price increases (Zhang, 2013), the findings from this study would inform central bankers of the need to map out a synergy with the financial institutions providing housing credit to adjust mortgage interest rates so that they are in line with the overall inflation target.

Following this introduction, the remainder of the paper is structured as follows. While Section 2 discusses the data and summary statistics. Section 3 presents the technique upon which the analyses are conducted. In Section 4, we systematically presented and discussed our results, while we conclude in Section 5.

## 2. Theoretical Issues

One prominent theory expatiating the house prices-inflation nexus is the credit channel of monetary transmission mechanisms, referred to as the credit channel, which focuses on the firms' behaviour, but the theory also applies to the behaviour of households (Bernanke and Gertler 1995). Asset prices are essential factors in the monetary transmission mechanisms since they determine the value of wealth and, therefore, the value of the collateral used to obtain loans from banks. As explained by Bernanke and Gertler (1995), a higher net worth of homeowners leads to more collateral for their loans, which reduces the probability of defaulting on debt. Therefore, banks can issue a more favourable mortgage interest rate, expressed as a lower external finance premium. The external finance premium is known as the risk premium on top of the risk-free rate. The size of the external finance premium depends on the sum of a borrower's liquid assets and their collateral (Bernanke and Gertler, 1995; Cambazoğlu and Karaalp, 2013; Gertler and Gilchrist, 2018). In the case of household borrowing, the collateral typically consists of the value of the house (Cooper, 2013; Mian and Sufi, 2011; Schmalz *et al*., 2017)

The intuition behind why the Central Bank's policy rate influences the external finance premium is that changes in policy rates affect the financial position of borrowers. For instance, declining interest rates increase house prices and consequently expand collateral for existing households, reducing default risks on the debt, lowering external finance premiums and making it easier for existing households to raise more debt. This expanded collateral enables what is called mortgage equity withdrawal, i.e., loans added to existing mortgages, which in turn stimulates spending on consumer goods. An intuitive example would be a household that borrows to buy a car with the house as security. Furthermore, the magnitude of the credit channel depends on the level of collateral constraint, as well as the cost of withdrawing home equity, which in turn depends on the efficiency of the mortgage market (Bhutta and Keys, 2016;

Chatterjee and Eyigungor, 2015; Mishkin 2007). In other words, the credit channel's effect depends on the country's economic setting and regulations.

Additionally, the degree of mortgage system liberalization is another factor affecting the magnitude of the credit channel as it determines the price of home equity withdrawal. Therefore, Aoki *et al*. (2004), Aron *et al*. (2012) and Ramcharan and Crowe (2013) contended that a change in house price has a more significant effect on consumption through the Credit channel, as the degree of credit constraint and liberalization determines the magnitude of the credit channel in the short to medium term. However, these effects are mainly focused on existing loans and not the turnover of the housing market, i.e., credit turnover. In the long run, the impact of the credit channel ought to be independent of credit constraint or the degree of liberalization since buyers of houses tend to maximize the credit, replacing the non-credit-constrained sellers. In other words, the buyers have higher loan-to-value than the sellers in general, increasing the level of credit in the long run, given that the house prices rise.

## 2.1 A brief review of related empirical studies

There have been a replete of empirical studies examining the house price-inflation nexus in order to establish cointegration between them. These studies range from country-specific (see Amonhaemanon *et al*., 2013; Cho, 2006; Iacoviello and Neri, 2010; Inglesi-Lotz & Gupta, 2013; Korkmaz, 2019; Lee, 2013) to country-time studies (see Bao *et al*., 2022; Kuang & Liu, 2015; Leombroni *et al*., 2020; Reilly *et al*., 1977' Rubens *et al*., 1989; Tang *et al*., 2019). The investigation comes in divergent exploration, some studies twilight on the nexus between inflation and asset returns (see Barnes *et al*., 1999; Cieslak and Pflueger, 2023; Engsted and Tanggaard, 2002; Eugene and Schwert, 1977; Lee, 2003; Naranjo and Ling , 1997; Moerman and van Dijk, 2010), few on stock returns and inflation (Boudoukh and Richardson , 1993; Choudhry, 2001; Kim and In, 2005; VanderHoff and VanderHoff, 1986), ample focuses on housing investment as hedge against inflation (Christou *et al*., 2018; Fehrle, 2023; Kuan-Min *et al*., 2008; Nguyen, 2013) and majority directly exposes the symmetry association between housing price and inflation (Anari and Kolari, 2002; Black and Hoben, 1985; Christou *et al*., 2018; Clapp and Giaccotto, 1994; Dougherty and Van Order , 1982; Goodhart and Hofmann, 2008; Hin Li.and Lin Ge, 2008; Hossain and Latif , 2009; Inglesi-Lotz and Gupta, 2013; Jafari Samimi *et al*., 2007; Korkmaz, 2019; Kuang and Liu , 2015; Kuang and Liu Munro, 2018; Schwab, 1982;Tang *et al*., 2018).

Interestingly, the study of Kuan-Min et al., 2008 explored the asymmetric nexus between housing price and inflation using the threshold vector error correction model (TVECM), where two inflation regimes – high and low inflation regimes – were studied based on the inflation value threshold. Their findings submtieed that change in the consumer price index (CPI) affect change in the housing price index at any time, as the presence of the threshold value validates the CPI response to housing price in relation to asymmetric momentum, establishing that the short-run adjustment is asymmetric, the causality under the upper and lower inflation regime is inconsistent lading way to one-way infaltaio0shouing return causality under high inflation regime. Another similar study by Peretti *et al*. (2012) used the time-varying vector autoregressive (TVP-VAR) to examine the existence of spillovers from the housing sector onto consumption in South Africa. Empirically, they assert that consumption responded positively to house price shock, especially during post-financial liberalization, while there was a nominal interest rate positive delayed response to house shock post-financial liberalization, leading to the assertion that the effect of house prices on both consumption and interest rate was understandably weak during the financial crisis.

Furthermore, some studies focused on the real estate's ability to hedge against exchange rate, interest rate and inflation by investigating the correlations between one or a combination of these variables and housing price cum real estate investment. For instance, Goodhart and Hofmann (2008) showed that lower interest rates engineer an increase in real estate investment leading to a reduction in house prices. Meanwhile, Lee and Lin (2012) argued depreciating currency could increase the cost of construction materials, thereby affecting the housing market, as male householders, higher education level, and higher environment satisfaction also contributed to unaffordable housing, while higher income, public transfer receipt decreases unaffordable housing odds. Accordingly, Salisu *et al*. (2024) argued after examining the dynamic relationship between exchange rates and housing affordability and their behaviour during high and low inflation regimes and turbulent times for 18 OECD countries that exchange rate appreciation improves housing affordability, as inflation can worsen housing affordability during turbulent times, like the global financial crisis.

Several studies focusing on the real estate's ability to hedge against inflation investigated the correlations between inflation and rates of return on real estate. For instance, a study by Inglesi-Lotz and Gupta (2013) examined whether house prices provide a suitable hedge against inflation in South Africa using autoregressive distributed lag (ARDL) models and concluded that there is a long-run cointegration between house prices of all the segments and the consumer price index excluding housing costs. Meanwhile, Spellman (1981) concluded that house prices grew more rapidly than both the rents and inflation over the in the early 80s. Also, there are studies on real estate as an inflation hedge, employing regression analyses similar to Fang *et al*. (2008), Hartzell *et al*. (1987), Hoesli (1994), Park and Bang (2012) and Rubens *et al*. (1989) studies. Such studies include Salisu *et al*. (2020), where a comparative analysis of inflation hedging properties of stocks, gold and real estate in the US was hypothesised that the assets have varying market characteristics and are expected to respond differently to high inflation. They established that inflation hedging tendencies of assets are heterogeneous across the considered assets, as real estate and stocks prove to be good hedges against inflation, while gold investment defies Fisher's hypothesis. Their assertion was in consonance with the work of Glascock *et al*. (2002), Hofman and Aalbers (2019), Inglesi-Lotz and Gupta (2013) and Lee and Lee (2012).

Furthermore, Muckenhaupt *et al*. (2023) examined the inflation-hedging capability of listed real estate (LRE) companies in the US from 1975 to 2023 and in three economies – the UK, Japan, and Australia – from 1990 to 2023 via the Markov switching vector error correction model (MS-VECM). They identified that the short-term hedging ability moves towards being negative or zero during turbulent periods, while LRE provides good protection against inflation in the stable period, as inflation-hedging portfolios minimise the expected shortfall, suggesting that listed real estate stocks should play a significant role in investor portfolios. Finally, there are two groups of ideas concerning house prices – inflation nexus as revamped by Korkmaz (2019). The first thought reiterates that inflation and house prices have a positive association (see Bao *et al*., 2022; Christou *et al*., 2018; Dougherty and Van Order, 1982; Follain Jr, 1982; Hin Li and Lin Ge, 2008; Kuang and Liu, 2015; Manchester, 1987; Nguyen *et al*., 2010), while the other view suggests a housing prices-inflation negative association (see Füss and Zietz, 2016; Guo *et al*., 2015; Tkacz and Wilkins, 2008).

The present study arises in other to examine the housing price-inflation nexus in the OECD context, as the majority of the studies have not delved into these, likewise establishing what has transpired between housing prices and inflation during the global financial crisis and the COVID-19 pandemic period when these variables are controlled with economic growth indicator. These are a few of the gaps that our attention is focused on filling and contributing to the body of literature, as these have not been unbundled earlier.

## 3. Data and Summary Statistics

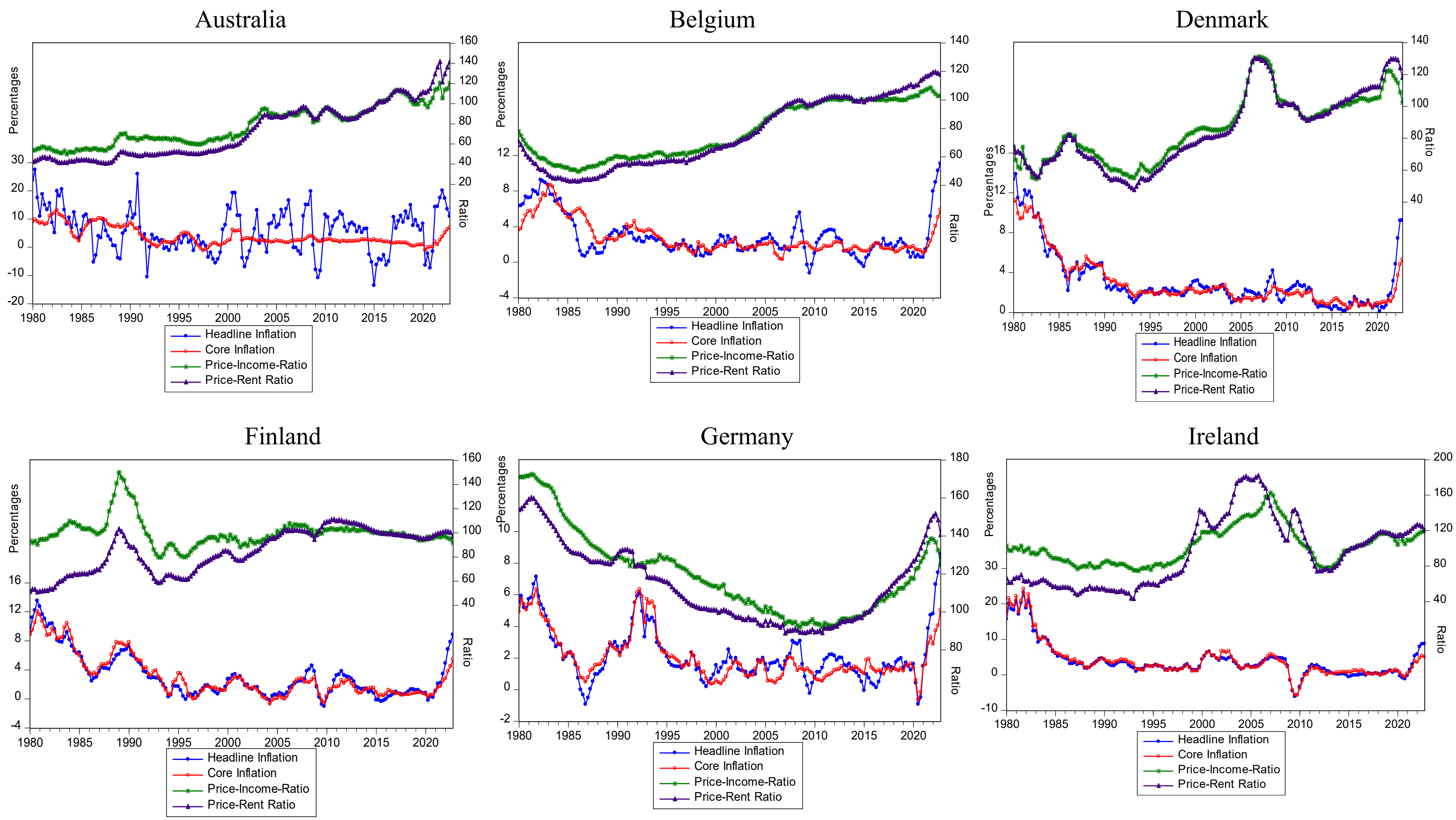
We utilize a quarterly dataset on Price-Income-Ratio, Price-Rent-Ratio, Headline Inflation, and Core Inflation to establish the connection between housing prices and inflation in OECD countries. The data spans from 1980Q1 to 2022Q4, and the selected OECD countries include Australia, Belgium, Canada, Denmark, Finland, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, and the USA. All these data were sourced from the OECD online database via https://data.oecd.org. These countries are selected as they constitute more than 70% of the OECD Gross Domestic Product (GDP) and are among the countries with a complete data set for the analysis (see https://data.oecd.org/gdp/gross-domestic-product-gdp.htm). We provide some statistical characteristics of the series by conducting descriptive statistics for the analysis (see Table 1). The mean, standard deviation, and the coefficient of variation are the main focus of this analysis. The mean values represent the averages of the series per country, and the standard deviation explains the dispersion of the series around the mean. While the coefficient of variations explains the volatility in the variables among the countries. Notably, Japan tops the OECD countries as the most expensive housing prices economy across the three proxies of housing prices under consideration, with a nominal house rent price of 130.5080, price-income-ratio measure of 130.5080, and price-rent-ratio measure of 127.2683 respectively. Australia reveals the cheapest housing prices relative to a nominal house rent price of 52.9820, and Sweden portrays the cheapest housing prices at 76.2500 when considering using the price-income ratio for housing prices, while Norway ranks the lowest with a price-rent ratio of 68.5715. Regarding the volatility of housing prices among the OECD countries, the US exhibits the least volatile housing prices, whereas the Netherlands tops housing price volatility when considering the price-income ratio as a measure of housing prices.

Similarly, Canada tops housing price volatility when considering using the price-rent-ratio measure of house prices among OECD countries. In another vein, Japan recorded the lowest mean values of both headline and core inflation of 0.9755 and 0.8731, respectively, while Australia depicts the highest value of 5.8828 for headline inflation as Italy tops core inflation values for the period under study. To visually inspect potential co-movement between housing prices and inflation, we have plotted the Price-Income-Ratio and Price-Rent-Ratio against the Headline and Core Inflation variables (refer to Figure 1). Evidently, there appears to be a possible interaction among these variables.

**Table 1: Descriptive Statistics**

| | Nominal House Rent | | | Price-Income-Ratio | | | Price-Rent-Ratio | | | Headline Inflation | | | Core Inflation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Country** | **Mean** | **Std. dev** | **CV** | **Mean** | **Std. dev** | **CV** | **Mean** | **Std. dev** | **CV** | **Mean** | **Std. dev** | **CV** | **Mean** | **Std. dev** | **CV** |
| **Australia** | 52.9820 | 38.0296 | 71.7 | 77.8953 | 19.2355 | 24.6 | 72.6937 | 27.1019 | 37.2 | 5.8828 | 7.6810 | 130.5 | 3.8342 | 3.16055 | 82.4 |
| **Belgium** | 77.68544 | 19.20845 | 24.7 | 77.6854 | 19.2084 | 24.7 | 75.9666 | 24.1983 | 31.8 | 2.8514 | 2.3168 | 81.2 | 2.7342 | 1.77516 | 64.9 |
| **Canada** | 83.12496 | 22.42241 | 26.9 | 83.1249 | 22.4224 | 26.9 | 69.9948 | 32.5523 | 46.5 | 3.1771 | 2.7114 | 85.3 | 3.0595 | 2.5611 | 83.7 |
| **Denmark** | 86.44590 | 20.79341 | 24.0 | 86.4459 | 20.7934 | 24.0 | 85.0445 | 23.4722 | 27.5 | 3.1061 | 2.8746 | 92.5 | 2.9816 | 2.5466 | 85.4 |
| **Finland** | 100.0397 | 11.58273 | 11.5 | 100.0397 | 11.5827 | 11.5 | 84.8754 | 17.6135 | 20.7 | 3.1003 | 3.0701 | 99.0 | 3.0577 | 2.9537 | 96.5 |
| **Germany** | 120.1314 | 22.02895 | 18.3 | 120.1314 | 22.0289 | 18.3 | 114.5624 | 20.4259 | 17.8 | 2.1824 | 1.7208 | 78.8 | 2.0717 | 1.5254 | 73.6 |
| **Ireland** | 102.3018 | 21.05292 | 20.5 | 102.3018 | 21.0529 | 20.5 | 95.0159 | 38.7003 | 40.7 | 3.8092 | 4.9095 | 128.8 | 3.9713 | 5.1471 | 129.6 |
| **Italy** | 99.37436 | 14.22812 | 14.3 | 99.3743 | 14.2281 | 14.3 | 111.4377 | 17.4240 | 15.6 | 4.6072 | 4.9130 | 106.6 | 4.5649 | 5.0591 | 110.8 |
| **Japan** | 130.5080 | 29.08638 | 22.2 | 130.5080 | 29.0863 | 22.2 | 127.2683 | 26.7518 | 21.0 | 0.9755 | 1.7595 | 180.3 | 0.8731 | 1.5998 | 183.2 |
| **Nether-lands** | 97.31793 | 28.02901 | 28.8 | 94.52791 | 26.8883 | 28.4 | 101.8794 | 30.3485 | 29.7 | 2.4265 | 1.9426 | 80.0 | 2.3496 | 1.3751 | 58.5 |
| **Norway** | 83.58046 | 18.23421 | 21.8 | 83.58046 | 18.2342 | 21.8 | 68.5715 | 27.5999 | 40.2 | 3.7300 | 3.0872 | 82.7 | 3.5777 | 2.9335 | 81.9 |
| **Spain** | 97.79315 | 25.33877 | 25.9 | 97.79315 | 25.3387 | 25.9 | 97.8460 | 31.3889 | 32.0 | 4.6035 | 4.0826 | 88.6 | 4.4213 | 4.0668 | 91.9 |
| **Sweden** | 76.25007 | 18.23087 | 23.9 | 76.25007 | 18.2308 | 23.9 | 70.1408 | 25.6209 | 36.6 | 3.4737 | 3.7018 | 106.5 | 3.2132 | 3.5110 | 109.2 |
| **Switzer-land** | 100.7733 | 19.45377 | 19.3 | 100.7733 | 19.4537 | 19.3 | 98.4389 | 17.0052 | 17.2 | 1.5960 | 1.9136 | 119.8 | 1.6390 | 1.9347 | 118.0 |
| **US** | 112.4882 | 10.71112 | 9.5 | 112.4882 | 10.7111 | 9.5 | 100.8738 | 12.1474 | 12.0 | 3.3267 | 2.5264 | 75.9 | 3.3584 | 2.2873 | 68.1 |

Source: Authors' own work


Australia
Percentages
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Price-Rent Ratio
Belgium
Percentages
Ratio
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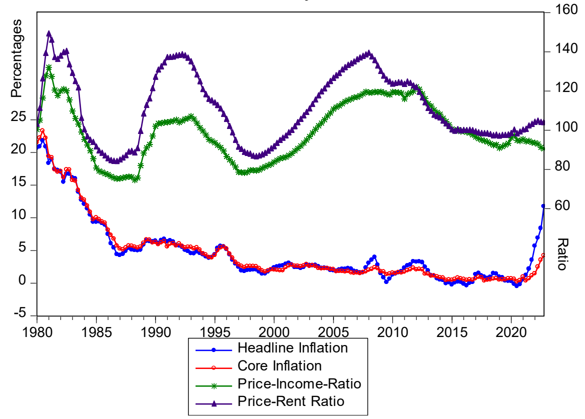
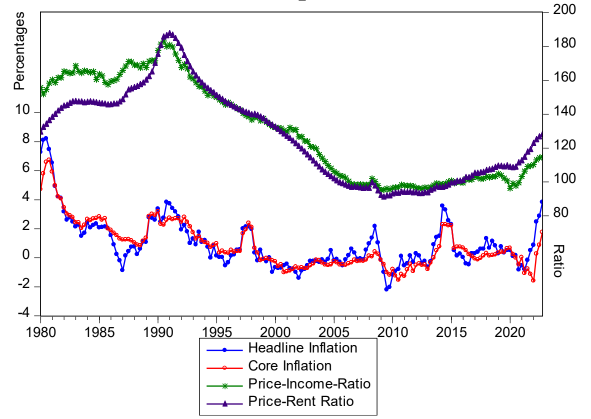
Price-Rent Ratio

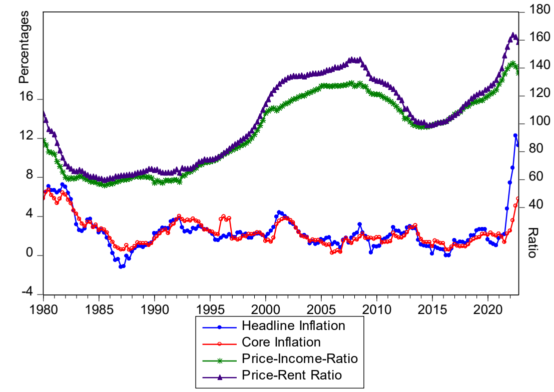
Italy



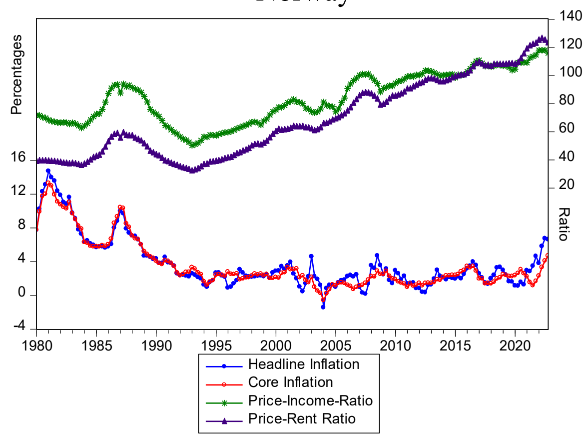

Japan



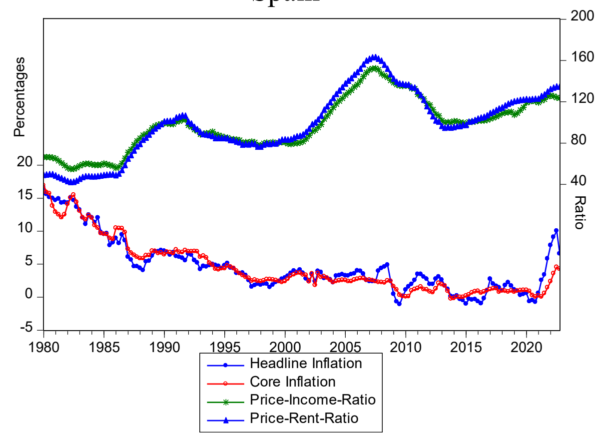

Netherlands



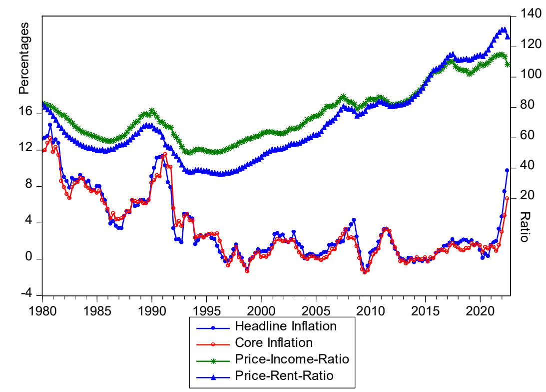

Norway




Spain




Sweden




**Switzerland**

**USA**

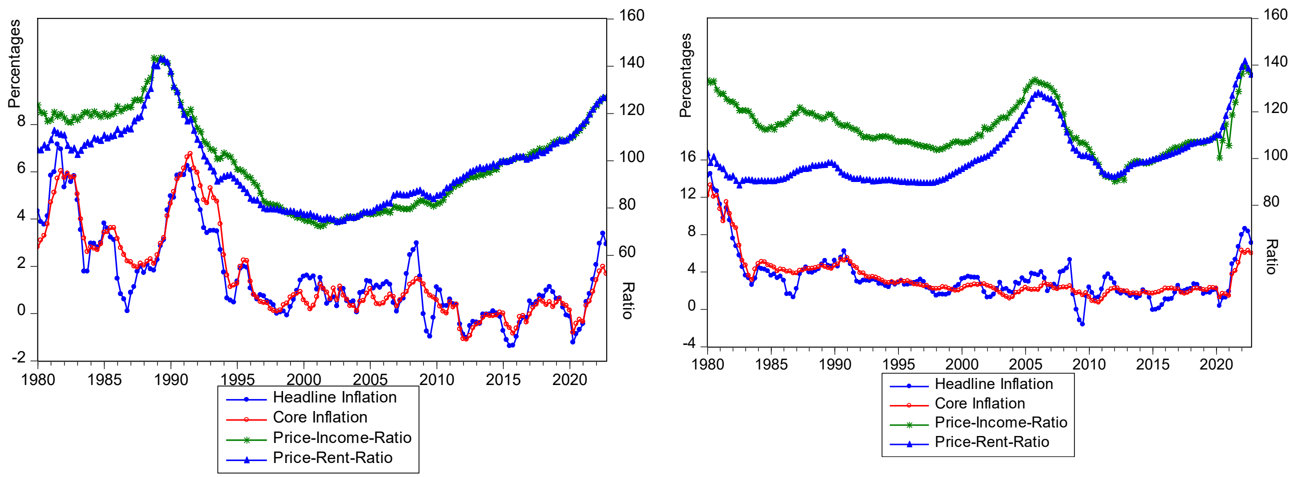



**Fig. 1:** Graphs showing the relationship between housing prices and inflation in OECD countries
Source: Authors' own work

## 4. Methodology

The panel Autoregressive Distributed Lag (PARDL) approach is utilised in examining the association between housing affordability and inflation rate – proxied with headline and core inflation – for OECD member countries, putting into consideration the role the global financial crisis (GFC) and Covid-19 pandemic played in this nexus. It should be noted that rising house prices directly affect household income and house affordability, likewise, the inflation rate. Accordingly, in line with theory, a slight increase in housing rents and home prices has traceable impacts on inflation – as inflation measures the price of commodities (which shelter is a fraction) households consume, contrary to the value of investment assets that families possess. Having said this, theoretically, we hypothesize a direct (positive) nexus between housing affordability and the inflation rate, as higher house rent rates positively influence and pressurize the inflation rate, *ceteris paribus*.

Since the variables deployed are characterized by large cross-sectional units (N) and time series (T), the non-stationary heterogeneous panel is considered appropriate. The usage enables us to capture the various characteristics of studied countries cum estimating various short-run and long-run dynamics in the relationship between housing affordability and inflation rate, such that different specifications regarding cross-sectional slope coefficients are easily accommodated. More so, we employ the MG estimator, which captures the inherent heterogeneity across the OECD countries' housing prices and inflation rates, both in the long and short run, including the error correction estimates. This selection is premised on its flexibility and capacity to account for more heterogeneous dynamics in the slope coefficients.

In achieving the study's aims, different models are specified. One, we examine the nexus between housing affordability and inflation. Similarly, this nexus is further examined during the tranquil (pre-GFC) and turbulent (GFC and COVID-19) periods. Consequently, the first objective is captured by specifying the panel autoregressive distributed lag model for the nexus between migration and inflation as:

$$\Delta cpi_{it} = \partial_i cpi_{i,t-1} + \theta_i + \delta_i X_{i,t-1} + \sum_{j=1}^{r} \pi_{ij} \Delta cpi_{i,t-j} + \sum_{j=0}^{s} \eta_{ij} \Delta X_{i,t-j} + \varepsilon_i + \nu_{it} \tag{1}$$

where $cpi_{it}$ denotes the consumer prices – either core or headline – proxies inflation, making up two regression panels A and B, expressed in natural logs for country *i* over a specified period *t*; $X_{it}$ is a $k \times 1$ vector of the explanatory variables; $\theta_i$ is the state-specific intercept; $\Delta$ indicates the first difference operator; $\varepsilon_i$ is for the state-specific effects; and $\nu_{it}$ connotes stochastic disturbance term. Furthermore, while the short-run impact of housing affordability on inflation is $\eta_{ij}$, $-\delta_i / \partial_i$ measures the long-run effect. A principal feature of cointegrated variables is their responsiveness to any deviation from long-run equilibrium. This attribute infers an error correction model in which the short-run dynamics of the variables in the system are influenced by the deviation from equilibrium (Blackburne III and Frank, 2007).

The corresponding error correction form for equation (1) is specified as:

$$\Delta cpi_{it} = \partial_i e_{i,t-1} + \sum_{j=1}^{r} \pi_{ij} \Delta cpi_{i,t-j} + \sum_{j=0}^{s} \eta_{ij} \Delta X_{i,t-j} + \varepsilon_i + \nu_{it} \tag{2}$$

where $e_{i,t-1}$ is the error correction term and the speed of adjustment factor is $\partial_i$ which measures how long it takes the system to revert to the original equilibrium where it is confronted with shocks. In other words, if $\partial_i = 0$, then there would be no evidence for a long-run relationship; however, for long-run equilibrium to exist, the parameter is expected to be significantly negative. The closer the value of this parameter to one in absolute terms, the quicker the adjustment of inflation to long-run equilibrium after a change in the independent variable(s) – computed as $\left( 1 / e_{i,t-1} \right)$–; otherwise, the speed of adjustment to equilibrium will be slow, and therefore, it will take a longer period for the long-run equilibrium to be realized.

To capture more dynamics as enshrined in objective one, equation (1) is further partitioned to allow for the role of GFC in the nexus, wherein we employ a dummy to distinguish pre-GFC estimates from post-GFC:

$$\begin{aligned} \Delta cpi_{it} = {} & \rho_i cpi_{i,t-1} + \alpha_i + \phi_i^{PREGFC} X_{i,t-1} * D_t^{PREGFC} + \phi_i^{POSTGFC} X_{i,t-1} \left(1 - D_t^{PREGFC}\right) \\ & + \sum_{j=1}^{p} \lambda_{ij} \Delta h_{i,t-j} + \sum_{j=0}^{q} \gamma_{ij}^{PREGFC} \Delta X_{i,t-j} * D_t^{PREGFC} + \sum_{j=0}^{q} \gamma_{ij}^{POSTGFC} \Delta X_{i,t-j} * \left(1 - D_t^{PREGFC}\right) + \mu_i + \upsilon_{it} \end{aligned} \tag{3}$$

We separate the pre- and post-GFC estimates with the use of dummy variables where $D_t^{PREGFC}$ is the dummy variable for the pre-GFC and takes the value of one from 1987-2007 and zero otherwise, and $\left(1 - D_t^{PREGFC}\right)$ is for the post-GFC. The determination of both long-run and short-run estimates follows the same approach as equation (1), except that the estimates for pre- and post-GFC are distinctly derived. Finally, we account for an important driver of inflation, which is output (using the Gross Domestic Product as a proxy), whose theoretical foundation hinges on the new Keynesian perspective to output-inflation trade-off where a negative relationship is hypothesized between output and inflation with a plethora of evidence supporting the hypothesis at least in the short run (see, for a review of both the empirical and theoretical literature, Sim, 2021).

In terms of estimation, we adopt the two prominent methods for Panel ARDL analyses, namely the Pooled Mean Group (PMG) (see Pesaran *et al*., 1997) and the Mean Group (MG) (see Pesaran and Smith, 1995) estimators. The difference between the two estimators lies in how the long-run estimates are treated. While all the parameters, such as the intercepts, slope coefficients, and error variances, are all allowed to differ across groups in the case of the MG estimator, the PMG estimator constrains the long-run coefficients to be equal across groups while the intercept, short-run coefficients, and error variances are allowed to differ across the groups (as would the MG estimator). To choose between the MG and PMG estimators, the familiar Hausman test is performed where a non-rejection of the null hypothesis implies the adoption of the PMG while a rejection favours the MG estimator (see also Blackburne III and Frank, 2007).

## 5. The Results

### 5.1 Preliminary Tests

One of the justifications for using the Panel ARDL model is the unit root properties of the time series of the panel data framework. We perform some panel unit root tests to establish this condition. The first type of these tests involves panel unit root tests with the null hypothesis of unit root with the common process (see Breitung, 2000; Harris and Tzavalis, 1999; Levin *et al*., 2002 tests); the second type assumes unit root with individual unit root process (Im *et al*., 2003; ADF Fisher tests) and the one that accounts for cross-sectional dependency (see Pesaran, 2007). We perform the test on the variables of interest, headline and core cpi, price-rent ( $prr$ ) and price- income ( $pir$ ) ratios, as well as our control variable real Gross Domestic Product (GDP). Overall, all the explained variables – headline and core cpi – were stationary after first differencing – I (1) – under all the unit root techniques except core that was stationary at level – I (0) – under LLC. Also, all the explanatory variables were stationary at I (1) save price-income ratio ( $pir$ ) that became stationary at I (0) (see Table 2 for the panel unit root test results). This mixed behaviour of the integration properties of the variables further validates our choice of the Panel ARDL framework.

**Table 2: Panel Unit root tests**

| Test Method | $headline$ | $core$ | $prr$ | $pir$ | $gdp$ |
|---|---|---|---|---|---|
| ***Null Hypothesis: Unit Root with common process*** | | | | | |
| Harris-Tzavalis [rho] | 0.3206***$^{b}$ | -0.0580***$^{b}$ | 0.6429***$^{b}$ | 0.3417***$^{b}$ | -0.0298***$^{b}$ |
| Breitung [t-stat.] | -16.2161***$^{b}$ | -18.4745*$^{b}$ | -9.7295***$^{b}$ | -13.1311***$^{b}$ | -31.1201**$^{b}$ |
| LLC [t*] | -9.2772***$^{b}$ | -9.5110***$^{a}$ | -7.9114***$^{b}$ | -13.2170***$^{b}$ | -20.9701***$^{b}$ |
| ***Null Hypothesis: Unit Root with Individual process*** | | | | | |
| IPS (*W Stat*) | -25.1527***$^{b}$ | -5.0527***$^{a}$ | -18.2585***$^{b}$ | -26.4702***$^{b}$ | -34.0726***$^{b}$ |
| ADF Fisher [Chi-square] | 7.5059***$^{b}$ | 5.4528***$^{b}$ | 18.8067***$^{b}$ | 1.7315**$^{a}$ | 27.9472***$^{b}$ |
| ***Null Hypothesis: Unit Root with cross-sectional dependence*** | | | | | |
| Pesaran CD test [z[t-bar]] | -16.141***$^{b}$ | -14.547***$^{b}$ | -11.598***$^{b}$ | -13.242***$^{b}$ | -17.1433***$^{b}$ |
| *Number of Cross-Sections* | 15 | 15 | 15 | 15 | 15 |
| *Number of Periods* | 172 | 172 | 172 | 172 | 172 |
| *Total Number of Obs* | 2580 | 2580 | 2580 | 2580 | 2580 |

**Source: Authors' own work**
**Note: a and b denote stationarity at level and at first difference, respectively, while ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.**

To investigate the possible existence of cross-sectional dependence and slope homogeneity, we used the CD test as initiated by Pesaran (2004), the Breusch-Pagan LM, the biased-adjusted LM test by Pesaran *et al*. (2008), and the $\hat{\Delta}$ with the $\hat{\Delta}_{adj}$ by Pesaran and Yamagata (2008) for slope heterogeneity. It should be established that the CD test is robust to the non-normality of errors and structural breaks as it focuses more on the cross-sectional unit of the panel than the times' dimension. At the same time, the bias-adjusted LM was used as a supplement to the CD test's result. Two of the CD test accepted the null hypothesis under the headline, while all three tests accepted CD under the core. The slope heterogeneity was tested using the Pesaran and Yamagata (2008) test, The slope of homogeneity tests revealed that the slope is homogeneous under core and headline, as evident from the test statistics employed, whose Pesaran and Yamagata critical values, were statistically not significant. The CD and slope homogeneity test results are presented in Table 3:

**Table 3: Cross-sectional Dependence and Slope homogeneity tests**

| | Core | Headline |
|---|---|---|
| Cross sectional dependence test result | | |
| Pesaran CD test | 0.948 | 0.6055 |
| Bias Adjusted LM test | 0.254 | -1.897* |
| Breusch-Pagan LM test | 108.68 | 0.606 |
| Slope Homogeneity Test Result | | |
| $\hat{\Delta}$ | 0.708 | 0.780 |
| $\Delta_{adj}$ | 0.780 | 0.777 |

**The null hypotheses are no cross-sectional dependence and slope homogeneity, respectively**
**Note: *, **, *** indicate that statistics are significant at the 10%, 5%, and 1% level of significance, respectively**
**Source: Authors' work**

A cursory view of the correlation matrix in Table 4 shows that there is a weak association among the explanatory variables employed in the study. For instance, PRR and PIR had a 0.253 correlation coefficient, signalling that the relationship between the two is a positive weak association, as PRR and GDP also depict a positive weak correlation coefficient of 0.238. Hence, we can assert that there is no multicollinearity in the data set. Furthermore, using the variance inflation factor (VIF), the absence or presence of multicollinearity can be detected among the independent variables in a regression model. As depicted in Table 4, each of the independent variables does not have a VIF greater than 10. Likewise, the mean value of the VIF is 4.42, indicating that multicollinearity is not present as the standard errors are inflated by 4.42 degrees, which signifies the absence of multicollinearity.

**Table 4A: Housing – Inflation nexus for the OECD countries [using Price-Income Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.0175*** | -0.0168*** | -0.0184*** | -0.0177*** | -0.0306*** | -0.0308*** | -0.0175*** | -0.0321*** |
| | (0.00207) | (0.00178) | (0.00256) | (0.00204) | (0.00432) | (0.00272) | (0.00299) | (0.00387) |
| D.Housing | -0.0235** | -0.0185 | -0.0373*** | -0.0339*** | -0.0230** | -0.0239** | -0.0405*** | -0.0335*** |
| | (0.0109) | (0.0117) | (0.0105) | (0.0119) | (0.00977) | (0.00980) | (0.0103) | (0.00849) |
| Housing | 0.308 | 0.120*** | 0.771* | 0.742*** | -0.211 | 0.0799*** | 1.220 | 0.325*** |
| | (0.189) | (0.0358) | (0.452) | (0.0344) | (0.455) | (0.0274) | (0.892) | (0.0358) |
| D.GDP | | | | | -0.0189** | -0.0125** | -0.0529*** | -0.0289*** |
| | | | | | (0.00807) | (0.00511) | (0.00630) | (0.00838) |
| GDP | | | | | -0.450 | 0.688** | 16.64 | 2.319*** |
| | | | | | (1.869) | (0.281) | (10.73) | (0.334) |
| Constant | 0.0565*** | 0.0710*** | 0.0192 | 0.0244*** | 0.111*** | 0.120*** | 0.0194 | 0.0898*** |
| | (0.0136) | (0.00695) | (0.0149) | (0.00239) | (0.0246) | (0.00927) | (0.0140) | (0.0107) |
| Hausman test | | 1.02 | | 0.00 | | 0.41 | | 4.28 |
| Obs. | 2,565 | 2,565 | 2,565 | 2,565 | 2,550 | 2,550 | 2,550 | 2,550 |

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Housing is the natural log of the Price-Income ratio, and its coefficient denotes the long-run estimate, while the D.Housing is for the short run where the 'D' is the first difference operator; ec is the error correction term. GDP is the control variable, and it is also measured in natural logs. The Hausman test is performed to choose between the MG and the PMG estimators, where a non-rejection of the null hypothesis implies the adoption of the PMG while a rejection favours the MG estimator.

**Table 4B: Housing – Inflation nexus for the OECD countries [using Price-Rent Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.0177*** | -0.0159*** | -0.0207*** | -0.0200*** | -0.0288*** | -0.0301*** | -0.0204*** | -0.0317*** |
| | (0.00222) | (0.00237) | (0.00268) | (0.00251) | (0.00447) | (0.00291) | (0.00348) | (0.00336) |
| D.Housing | -0.0287** | -0.0291** | -0.0436*** | -0.0377** | -0.0386*** | -0.0385*** | -0.0472*** | -0.0412*** |
| | (0.0126) | (0.0141) | (0.0147) | (0.0151) | (0.0123) | (0.0116) | (0.0158) | (0.0123) |
| Housing | 0.204 | 0.368*** | 0.376 | 0.509*** | 0.0840 | 0.0813*** | 0.425 | 0.289*** |
| | (0.166) | (0.0229) | (0.307) | (0.0186) | (0.184) | (0.0240) | (0.332) | (0.0299) |
| D.GDP | | | | | -0.0221*** | -0.0154*** | -0.0513*** | -0.0300*** |
| | | | | | (0.00854) | (0.00529) | (0.00688) | (0.00818) |
| GDP | | | | | 0.779 | 1.064*** | 5.761** | 2.510*** |
| | | | | | (1.051) | (0.303) | (2.486) | (0.352) |
| Constant | 0.0607*** | 0.0494*** | 0.0375** | 0.0488*** | 0.104*** | 0.117*** | 0.0408** | 0.0958*** |
| | (0.0124) | (0.00682) | (0.0148) | (0.00564) | (0.0228) | (0.00990) | (0.0167) | (0.0101) |
| Hausman test | | 0.99 | | 0.19 | | 0.38 | | 2.95 |
| Obs. | 2,565 | 2,565 | 2,565 | 2,565 | 2,550 | 2,550 | 2,550 | 2,550 |

Note: See note to Table 4A, except that the housing price indicator is now replaced with the Price-Rent ratio.

### 5.2 Empirical result

The estimation was carried out in tripartite – pre-and post-GFC and COVID-19 – with two distinct proxies for capturing housing price – price-income and price-rent ratios – and inflation rate – core and headline CPI. The housing-inflation nexus was estimated via the MG and PMG estimators, and given the non-significance of the Hausman test statistics for all the estimated models, we conclude that the Hausman test result aligns with the PMG as the efficient estimators. Hence, our interpretations begin with the error correction term, which is the first set of coefficients reported in all the Panel ARDL results tables (see Tables 5 (A&B), 6 (A&B) & 7 (A&B)). Also, it should be observed that each of the Table's Model A excludes the output proxy – GDP – with concentration mainly on the housing price-inflation nexus, while Model B includes it. This approach offers a form of robustness for the analyses and also allows us to revisit the output-inflation tradeoff for the OECD countries.

Furthermore, for long-run equilibrium to exist, the coefficient of the error correction term is expected to be significant and negative, and the closer the value of this coefficient to one in absolute terms, the quicker the adjustment of the dependent variable to its long-run equilibrium after a change in the independent variable(s); otherwise, it will take a longer period for the equilibrium to be restored. The adjustment is calculated by taking the inverse of the absolute value of the ECT to show how long it takes for the deviations from equilibrium to return to equilibrium (Pao and Tsai, 2010). As observed from all our results tables, all the coefficients for the error correction terms in the respective models are significantly negative, indicating the presence of long-run equilibrium. However, the coefficients are small, implying that inflation may take a while to return to long-run equilibrium after a change in migration inflows, among other variables. For instance, the OECD countries will take 59. 5 and 56.5 years to return to long-run equilibrium under housing-core CPI and housing-headline CPI nexuses, respectively $\left(i.e.,\ 1/0.0168\ \textit{and}\ 1/0.0177\right)$.

To establish an empirical link between housing (price-income and price-ren ratios) and inflation (core and headline) for the OECD countries, as prefaced under the motivation (see Table 5A and 5B). This relationship is examined for tranquil and turbulent economic periods proxied by pre- and post-GFC, respectively (see Table 6A and 7B). Similarly, the influence of COVID-19 is also examined for the nexus (see Tables 7A and 7B). The COVID-19 era made it difficult for many households to pay for shelter and seriously hurt the housing sector; hence, the OECD countries' governments responded with a wide array of measures to protect tenants and mortgage-holders, as well as support builders and lenders. Furthermore, the inflation spike and sharp escalation of geopolitical risk further fuelling inflation, as the 2020 average inflation rate was due to demand shock, whereas it averaged 2.06% in 2019. The decrease in housing demand was due to the pandemic.

**Table 5A: The role of the global financial crisis in the nexus [using Price-Income Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| **PRE-GFC** | | | | | | | | |
| ec | -0.0200*** | -0.0205*** | -0.0239*** | -0.0227*** | -0.0371*** | -0.0258*** | -0.0213*** | -0.0298*** |
| | (0.00208) | (0.00161) | (0.00232) | (0.00213) | (0.00615) | (0.00600) | (0.00385) | (0.00425) |
| D.Housing | -0.0273** | -0.0248** | -0.0390*** | -0.0365*** | -0.0311*** | -0.0362*** | -0.0358*** | -0.0369** |
| | (0.0111) | (0.0106) | (0.0139) | (0.0130) | (0.0114) | (0.0106) | (0.0132) | (0.0144) |
| Housing | 0.261 | 0.0635 | 0.740*** | 0.589*** | -0.0649 | 0.239*** | 22.11 | 0.407*** |
| | (0.204) | (0.0450) | (0.234) | (0.0353) | (0.150) | (0.0449) | (21.19) | (0.0522) |
| D.GDP | | | | | -0.0181 | -0.00708 | -0.0530*** | -0.0434*** |
| | | | | | (0.0161) | (0.0146) | (0.0143) | (0.0125) |
| GDP | | | | | -0.534 | -1.364** | 249.2 | 1.430** |
| | | | | | (1.029) | (0.535) | (243.9) | (0.567) |
| Constant | 0.0735*** | 0.0887*** | 0.0436*** | 0.0436*** | 0.132*** | 0.0831*** | 0.0332** | 0.0745*** |
| | (0.0180) | (0.00662) | (0.0134) | (0.00358) | (0.0302) | (0.0164) | (0.0137) | (0.0103) |
| Hausman test | | 0.98 | | 0.42 | | 4.66 | | 3.78 |
| Obs. | 1,635 | 1,635 | 1,635 | 1,635 | 1,620 | 1,620 | 1,620 | 1,620 |
| **POST-GFC** | | | | | | | | |
| ec | -0.0840*** | -0.0594** | -0.0791*** | -0.0323*** | -0.0868*** | -0.0315*** | -0.0700** | -0.0283*** |
| | (0.0319) | (0.0288) | (0.0267) | (0.0111) | (0.0323) | (0.0104) | (0.0306) | (0.00561) |
| D.Housing | 0.0118 | 0.00198 | -0.00391 | -0.00816 | 0.00941 | -0.00788 | -0.00276 | 0.00148 |
| | (0.0175) | (0.0209) | (0.0186) | (0.0133) | (0.0175) | (0.0166) | (0.0159) | (0.0161) |
| Housing | 0.0826 | -0.0435*** | 0.448 | 0.582*** | 0.0384 | -0.0526 | 0.509* | 0.360*** |
| | (0.126) | (0.0158) | (0.512) | (0.0897) | (0.125) | (0.0547) | (0.261) | (0.0791) |
| D.GDP | | | | | -0.0244 | -0.0355 | 0.0339 | 0.0671 |
| | | | | | (0.0353) | (0.0328) | (0.0372) | (0.0447) |
| GDP | | | | | 3.066*** | 3.200*** | 4.401* | 3.579*** |
| | | | | | (1.086) | (0.718) | (2.307) | (0.677) |
| Constant | 0.452** | 0.288** | 0.234* | 0.0649*** | 0.458** | 0.154*** | 0.243 | 0.0852*** |
| | (0.193) | (0.138) | (0.131) | (0.0212) | (0.201) | (0.0500) | (0.151) | (0.0165) |
| Hausman test | | 1.01 | | 0.07 | | 1.22 | | 0.42 |
| Obs. | 735 | 735 | 735 | 735 | 720 | 720 | 720 | 720 |

Note:See note to Table 4A.

**Table 5B: The role of the global financial crisis in the nexus [using Price-Rent Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| **PRE-GFC** | | | | | | | | |
| ec | -0.0189*** | -0.0204*** | -0.0226*** | -0.0245*** | -0.0179*** | -0.0195*** | -0.0225*** | -0.0236*** |
| | (0.00219) | (0.00159) | (0.00446) | (0.00262) | (0.00234) | (0.00149) | (0.00509) | (0.00436) |
| D.Housing | -0.0448** | -0.0400* | -0.0601*** | -0.0552*** | -0.0473** | -0.0415** | -0.0576*** | -0.0519*** |
| | (0.0214) | (0.0210) | (0.0167) | (0.0163) | (0.0201) | (0.0194) | (0.0163) | (0.0141) |
| Housing | 0.176 | 0.0738** | 0.439** | 0.430*** | -0.188 | 0.0720* | 0.278 | 0.323*** |
| | (0.205) | (0.0362) | (0.177) | (0.0213) | (0.530) | (0.0383) | (0.299) | (0.0204) |
| D.GDP | | | | | -0.0336** | -0.0342** | -0.0561*** | -0.0484*** |
| | | | | | (0.0164) | (0.0146) | (0.0132) | (0.0133) |
| GDP | | | | | 1.699 | 1.107 | -1.781 | 2.376*** |
| | | | | | (1.781) | (0.944) | (5.368) | (0.604) |
| Constant | 0.0653*** | 0.0876*** | 0.0363 | 0.0652*** | 0.0604*** | 0.0839*** | 0.0441* | 0.0741*** |
| | (0.0118) | (0.00631) | (0.0285) | (0.00642) | (0.0116) | (0.00588) | (0.0227) | (0.0128) |
| Hausman test | | 0.25 | | 0.00 | | 0.55 | | 0.89 |
| Obs. | 1,635 | 1,635 | 1,635 | 1,635 | 1,620 | 1,620 | 1,620 | 1,620 |
| **POST-GFC** | | | | | | | | |
| ec | -0.0813*** | -0.0299** | -0.0783*** | -0.0479* | -0.0888*** | -0.0268*** | -0.0797** | -0.0379*** |
| | (0.0309) | (0.0129) | (0.0297) | (0.0259) | (0.0315) | (0.00916) | (0.0322) | (0.00939) |
| D.Housing | 0.00782 | -0.00273 | 0.0131 | 0.0264 | -0.0184 | -0.0119 | -0.0107 | 0.00169 |
| | (0.0272) | (0.0267) | (0.0258) | (0.0278) | (0.0210) | (0.0130) | (0.0227) | (0.0244) |
| Housing | -0.229 | 0.167*** | 0.180 | -0.0377* | 0.202* | 0.0384 | 0.357* | 0.178*** |
| | (0.291) | (0.0356) | (0.183) | (0.0221) | (0.110) | (0.0529) | (0.190) | (0.0350) |
| D.GDP | | | | | -0.0163 | -0.0303 | 0.0491 | 0.0741* |
| | | | | | (0.0366) | (0.0308) | (0.0365) | (0.0437) |
| GDP | | | | | 1.188 | 3.667*** | 5.611* | 2.144*** |
| | | | | | (1.043) | (0.899) | (2.885) | (0.483) |
| Constant | 0.377** | 0.118** | 0.252* | 0.232* | 0.406** | 0.121*** | 0.305* | 0.145*** |
| | (0.155) | (0.0495) | (0.140) | (0.124) | (0.160) | (0.0401) | (0.159) | (0.0354) |
| Hausman test | | 1.88 | | 1.43 | | 28.28*** | | 1.57 |
| Obs. | 735 | 735 | 735 | 735 | 720 | 720 | 720 | 720 |

Note: See note to Table 4A, except that the housing price indicator is now replaced with the Price-Rent ratio.

The results for the nexus price-income ratio – inflation nexus are in Tables 5A and 5B. As previously noted, the PMG estimator is the efficient estimator given the non-rejection of the null hypothesis; hence, our focus is on the corresponding PMG results. We find evidence of a significant positive nexus between housing price (price -income ratio) and core inflation; however, this evidence only holds in the long run with only housing prices, but when output is added, the significant long-run relationship is upheld with a significant negative short-run nexus between housing price and core inflation. More so, the price-income ratio has a significant negative and positive association with headline inflation in the short- and long-run, respectively; this feat was also obtained when checking for robustness, though with lesser magnitude. On the contrary, as evident from Table 5B, there was a twist in the response of core inflation to the dynamics of house price (price-rent ratio). We find a significant negative and positive association between the price-rent ratio and inflation (core and headline) in the short- and long-run, respectively, the same scenario played out under the robust check.

Table 5B established that in the short run, as the housing price-rent ratio increases, it strikes a decrease in inflation (core and headline), suggesting that the price-rent ratio is not a volatile variable in OECD countries, as it impacts and association remains the same irrespective of the inflation methods. Meanwhile, in the long run, a higher price-rent ratio increases inflation – core and headline – as depicted in Table 5B. The resemblance in this result is that both price-income and price-rent ratios demonstrated a similar nexus with the duo inflation types – negative and positive in the short and long run, respectively – though the significance is recorded under the price-income ratio. The assertion of the positive association between housing prices and inflation, in the long run, was in line with the submission of Korkmaz (2019) when he found that housing price causes inflationary pressure in Turkey; likewise, the study of Leung and Tang (2023) and Azam Khan *et al*. (2023) employing the house price-income ratio, Chong (2023) for Australia argued that housing costs and prices pressure inflation in their various study domain. Thus, it is important to note that the direct association, in the long run, favours homeowners, especially those on mortgages. As house prices tend to increase faster than inflation, their investment does not lose value, making their mortgage balance unchanged; hence, inflation is a good hedge for house owners but a dilemma for house tenants in the long-run.

In another twist, when we subjected our study to tranquil and turbulent episodes, our results (see Table 6A and 6B) for the nexus were upheld in the long-run under both Models 6A and 6B based on the PMG estimator. One instructive evidence here is that housing price (price-income ratio) drives inflation (headline) in the long run in the pre-and post-GFC era, as it drags inflation (core) only in turbulent periods, as in the later, a higher price-income ratio decreases inflation. This portrays the price-income ratio as being volatile and recursive to inflationary pressure. Evidence from Table 6 affirms that in the short-run during tranquillity, housing price (price-income) drags inflation (core and headline) with a slightly different magnitude, whereas during turbulent price-income ratio does not have any short-run association with inflation. More so, from Table 6B, housing price (price-rent ratio) portrays a significant negative association with inflation (core and headline) in the short-run of the tranquillity episode. This connotes that both housing price proxies drag inflation indicators in the short-run significantly during the calm period, but in the long-run, only the price-rent ratio drives inflation as against what happened under the price-income ratio, where reverse was the case in the long-run. One interesting scenario that played out in our result was that during the turbulent period, house price (price-income ratio) mitigates (pressures) core (headline) inflation in the long-run.

Whereas, with the price-rent ratio, house price pressures (mitigates) core (headline) inflation in the long run. Another major contentment in the result is the alignment of the robust check with the main result generated without adding output (GDP) in the model.

**Table 6A: The COVID-19 effect on the relationship [using Price-Income Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.429*** | -0.303*** | -0.0290 | 0.125*** | -0.603*** | -0.245*** | -0.290 | -0.506*** |
| | (0.144) | (0.111) | (0.0651) | (0.0333) | (0.151) | (0.0806) | (0.259) | (0.142) |
| D.Housing | -0.00180 | 0.000528 | -0.168** | -0.0297 | 0.0755 | -0.0689 | -0.187** | -0.0721 |
| | (0.0456) | (0.0300) | (0.0840) | (0.0550) | (0.0751) | (0.0560) | (0.0883) | (0.0670) |
| Housing | -0.00304 | -0.182*** | -1.201 | -1.111*** | -0.457** | 0.0435 | -0.133 | 0.170*** |
| | (1.387) | (0.0287) | (1.651) | (0.204) | (0.229) | (0.0483) | (0.259) | (0.0429) |
| D.GDP | | | | | 0.0195 | 0.00161 | 0.0357 | 0.0290*** |
| | | | | | (0.0252) | (0.0153) | (0.0294) | (0.00977) |
| GDP | | | | | 0.564 | 0.338*** | -0.0209 | 0.00689 |
| | | | | | (0.509) | (0.106) | (0.224) | (0.0394) |
| Constant | 1.645* | 1.220** | -0.734** | -1.223*** | 3.041*** | 0.552* | -0.103 | 1.267*** |
| | (0.949) | (0.562) | (0.363) | (0.323) | (0.976) | (0.310) | (1.213) | (0.489) |
| Hausman test | | -16.57 | | 0.00 | | 13.80*** | | -66.30 |
| Obs. | 165 | 165 | 165 | 165 | 150 | 150 | 150 | 150 |

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Housing is the natural log of the Price-Income ratio, and its coefficient denotes the long-run estimate, while the D.Housing is for the short run where the 'D' is the first difference operator; ec is the error correction term. GDP is the control variable, and it is also measured in natural logs. The Hausman test is performed to choose between the MG and the PMG estimators, where a non-rejection of the null hypothesis implies the adoption of the PMG while a rejection favours the MG estimator.

**Table 6B: The COVID-19 effect on the relationship [using Price-Rent Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.218** | -0.0410*** | -0.326** | -0.172*** | -0.0872 | -0.0684*** | -0.112 | 0.123*** |
| | (0.0950) | (0.0115) | (0.134) | (0.0656) | (0.134) | (0.0172) | (0.198) | (0.0206) |
| D.Housing | -0.260*** | -0.168*** | -0.187** | -0.208*** | -0.175 | -0.151*** | -0.0292 | 0.133 |
| | (0.0888) | (0.0431) | (0.0852) | (0.0745) | (0.114) | (0.0464) | (0.129) | (0.0903) |
| Housing | 0.193 | 2.517*** | 0.288 | 1.227*** | 1.284 | 1.874*** | -0.523 | -1.276*** |
| | (0.187) | (0.975) | (0.243) | (0.182) | (6.005) | (0.634) | (0.618) | (0.475) |
| D.GDP | | | | | 0.00853 | 0.0334*** | 0.0671*** | 0.0524*** |
| | | | | | (0.0281) | (0.00931) | (0.0222) | (0.0115) |
| GDP | | | | | 6.453 | -0.913*** | 0.0894 | 0.479** |
| | | | | | (4.845) | (0.322) | (0.156) | (0.192) |
| Constant | 0.407 | -0.288*** | 0.316 | -0.274** | -0.276 | -0.278*** | -0.585 | -1.313*** |
| | (0.415) | (0.0794) | (0.525) | (0.112) | (0.630) | (0.0677) | (0.885) | (0.219) |
| Hausman test | | -5.90 | | 34.07*** | | 3.53 | | -7.76 |
| Obs. | 165 | 165 | 165 | 165 | 150 | 150 | 150 | 150 |

Note: See note to Table 4A, except that the housing price indicator is now replaced with the Price-Rent ratio.

We further examined the effect of Covid-19 on the house price-inflation nexus. The results for these are shown in Tables 7A and 7B, similarly focusing on the PMG estimator given the non-rejection of the null hypothesis. First, the error correction gives a more assuring restoration period as witnessed in previous Tables, echoing that despite the role Covid-19 played in the OECD economies, the countries will adjust to equilibrium faster than the pre- and post-GFC periods. For comparison, the shortest time it will take long-run equilibrium to manifest in the turbulent period was 20 years 7 months $(ie.,\ 1/0.0479)$, whereas, when conducted for COVID-19, long-run will happen within 3 years and 3 months $(ie.,\ 1/0.303)$. Also, we find that when the price-income ratio was used, housing prices had a significant negative association with inflation in the long-run. Meanwhile, when the price-rent ratio was employed, housing prices had a significant negative (positive) relationship with inflation in the short-(long-) run periods. This connotes that housing prices put more pressure on inflation in the long-run with the price-rent ratio as a proxy for the former.

**Table 7A: The COVID-19 effect on the relationship [using Price-Income Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.429*** | -0.303*** | -0.0290 | 0.125*** | -0.603*** | -0.245*** | -0.290 | -0.506*** |
| | (0.144) | (0.111) | (0.0651) | (0.0333) | (0.151) | (0.0806) | (0.259) | (0.142) |
| D.Housing | -0.00180 | 0.000528 | -0.168** | -0.0297 | 0.0755 | -0.0689 | -0.187** | -0.0721 |
| | (0.0456) | (0.0300) | (0.0840) | (0.0550) | (0.0751) | (0.0560) | (0.0883) | (0.0670) |
| Housing | -0.00304 | -0.182*** | -1.201 | -1.111*** | -0.457** | 0.0435 | -0.133 | 0.170*** |
| | (1.387) | (0.0287) | (1.651) | (0.204) | (0.229) | (0.0483) | (0.259) | (0.0429) |
| D.GDP | | | | | 0.0195 | 0.00161 | 0.0357 | 0.0290*** |
| | | | | | (0.0252) | (0.0153) | (0.0294) | (0.00977) |
| GDP | | | | | 0.564 | 0.338*** | -0.0209 | 0.00689 |
| | | | | | (0.509) | (0.106) | (0.224) | (0.0394) |
| Constant | 1.645* | 1.220** | -0.734** | -1.223*** | 3.041*** | 0.552* | -0.103 | 1.267*** |
| | (0.949) | (0.562) | (0.363) | (0.323) | (0.976) | (0.310) | (1.213) | (0.489) |
| Hausman test | | -16.57 | | 0.00 | | 13.80*** | | -66.30 |
| Obs. | 165 | 165 | 165 | 165 | 150 | 150 | 150 | 150 |

**Source: Authors' own work**
**Note: See note to Table 5A**.

**Table 7B: The COVID-19 effect on the relationship [using Price-Rent Ratio]**

| Variables | CORE | | HEADLINE | | CORE | | HEADLINE | |
|---|---|---|---|---|---|---|---|---|
| | MG | PMG | MG | PMG | MG | PMG | MG | PMG |
| ec | -0.218** | -0.0410*** | -0.326** | -0.172*** | -0.0872 | -0.0684*** | -0.112 | 0.123*** |
| | (0.0950) | (0.0115) | (0.134) | (0.0656) | (0.134) | (0.0172) | (0.198) | (0.0206) |
| D.Housing | -0.260*** | -0.168*** | -0.187** | -0.208*** | -0.175 | -0.151*** | -0.0292 | 0.133 |
| | (0.0888) | (0.0431) | (0.0852) | (0.0745) | (0.114) | (0.0464) | (0.129) | (0.0903) |
| Housing | 0.193 | 2.517*** | 0.288 | 1.227*** | 1.284 | 1.874*** | -0.523 | -1.276*** |
| | (0.187) | (0.975) | (0.243) | (0.182) | (6.005) | (0.634) | (0.618) | (0.475) |
| D.GDP | | | | | 0.00853 | 0.0334*** | 0.0671*** | 0.0524*** |
| | | | | | (0.0281) | (0.00931) | (0.0222) | (0.0115) |
| GDP | | | | | 6.453 | -0.913*** | 0.0894 | 0.479** |
| | | | | | (4.845) | (0.322) | (0.156) | (0.192) |
| Constant | 0.407 | -0.288*** | 0.316 | -0.274** | -0.276 | -0.278*** | -0.585 | -1.313*** |
| | (0.415) | (0.0794) | (0.525) | (0.112) | (0.630) | (0.0677) | (0.885) | (0.219) |
| Hausman test | | -5.90 | | 34.07*** | | 3.53 | | -7.76 |
| Obs. | 165 | 165 | 165 | 165 | 150 | 150 | 150 | 150 |

**Source: Authors' own work**
**Note: See note to Table 5A, except that the housing price indicator is now replaced with the Price-Rent ratio.**

Although this study does not focus on the connection between output and inflation, the results obtained in this regard are worth noting. In the short run, output (GDP) had a negative association with inflation, but in the long run, the relationship is positive, with exemptions of the long-run negative correlation witnessed in Table 6A (price-income and core inflation) and Table 7B (price-rent ratio and core); positive nexus observed in the short-run in Table 6B (price-rent and headline), Table 7A (price-income ratio and headline) and Table 7B (price-rent ratio and inflation). The reason for this outcome is that, in the short-run, an increase in output lowers prices. However, in the long-run, as more workers and capital are employed to increase output, wages may rise, which can push prices up over time (see Gordon, 1987; Heckman *et al*., 1998; Marglin, 2017). This can happen in two ways – cost-push and demand-pull inflation. The former is due to rising wages and increased demand for other inputs from producers, while the latter is triggered by increased demand for goods and services due to rising wages. Therefore, a positive relationship between output and inflation may not be farfetched, particularly for emerging and developed economies such as those in the OECD countries.

### 5.3. Policy Implication of Findings

The results obtained from various analyses possess significant implications for policy and investment decisions regarding the housing market and the economy as a whole. The housing market is an important indicator of the economic standard of living, and any developments in this market are expected to have far-reaching consequences on the overall economy. For instance, if the growth in housing prices exceeds the income growth, it may lead to a decline in the standard of living since housing units become unaffordable, thereby making it difficult to achieve development goals that are directly or indirectly linked to housing, such as improved health, reduced poverty, and energy security, among others.

Regarding the implications of our findings, we want to highlight two crucial points. Firstly, it is important to consider the exchange rate risk while pricing housing assets, as it has a significant impact on the housing market. This means that foreign investors participating in the housing market of OECD countries must continuously monitor the dollar-denominated exchange rate to ensure that their housing assets are appropriately priced.

Secondly, we urge relevant policy authorities, especially the fiscal and monetary authorities, to acknowledge the influence of inflation rates on the housing market and take necessary steps to mitigate continuous price fluctuations. This will not only stabilize the housing market but also have a more profound impact on the economy. For instance, if the inflation rate keeps soaring higher, it will impact the building costs and maintenance as well as other commodities, thereby leading to hiking housing prices by the respective landowners who want to meet up with fluctuations with prices reality in other consumption spheres. Furthermore, the persistent inflation rate will also reduce the purchasing power of prospective house seekers as most of their incomes have been expended on immediate consumption leaving them with few dollars on housing. The fiscal authority is advised to pursue a deflationary fiscal policy by increasing taxes and reducing government spending, while the monetary authorities are beseeched to increase the interest rate, in order to increase the cost of borrowing and reduce consumers' spending and investment (although, using a higher increase might reduce inflationary pressure, but could lead to a big fall in GDP). Hence, a long-term solution could be implementing supply-side policies that help to increase productivity, which could enable the achievement of macroeconomic goals so price stability within the OECD regions.

## 5 Conclusion

This study demonstrates the nexus between housing prices and inflation in OECD countries using a non-stationary heterogenous panel modelling framework to account for both the short and long-run dynamics. For emphasis, we employ the price-income ratio (PIR) and price-rent-ratio (PRR) as the predictors of both headline and core. The study conveys that core inflation responds more positively to housing prices than headline inflation, as it displayed a positive and significant long-run nexus with core inflation using the three indicators of housing prices. However, nominal house rent shows a negative and non-significant association with core inflation in the short run, with price-rent-ratio and price-income-ratio indicating a negative and significant relationship with core inflation using the full sample data.

We equally document the dynamics of housing prices on inflation (core and headline) in different sub-samples (pre-GFC, post-GFC, and the COVID-19 periods). However, during the pre-GFC era, it is evident that housing prices (both PRR and PIR) continued to exude it negative nexus on headline inflation in the short run. However, this appears to be a short-run phenomenon, as the long-run dynamics indicate a positive and significant nexus between housing prices and headline inflation. Relatedly, core inflation exhibits a negative nexus in the short-run; however, in the long-run, the price-rent ratio conveys a positive and significant nexus with core inflation. Regarding the post-GFC era, the price-income ratio conveys a positive (negative) but non-significant nexus towards core (headline) inflation in the short-run. However, this appears to be temporal as a price-rent ratio (price-income-ratio) renders negative (positive) and significant outcomes in the long run. Relatedly, core inflation portrays a positive (negative) non-significant nexus with the price-income ratio (price-rent-ratio); however, in the long run, there was nexus switching and significance. The post-global financial crisis and

COVID-19 era posit a mixed influence of housing prices on inflation both in the short and long-run.

It is clearly shown that housing prices are a relevant predictor of inflation dynamics in OECD-selected countries, with a higher predictive power on core inflation. From the policy perspective, the study offers reasonable insight into understanding monetary policy measures that guarantee stable inflation. It equally helps to understand housing price and inflation dynamics during turbulent and normal episodes. Policymakers and practitioners may equally use the study to evolve new monetary policy measures that enhance price stability in the OECD economies. Studying the potential asymmetric and nonlinear connection between housing prices and inflation can advance the literature and enhance our comprehension of the subject matter. We offer this as a suggestion for future research.

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