Exchange Rate and Housing Affordability in OECD Countries

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Abstract

Purpose

This study aims to construct alternative models to establish the dynamic relationship between exchange rates and housing affordability by estimating both the short and long-run relationship between exchange rates and housing affordability for 18 OECD countries from 1975Q1 to 2022Q4. After that, we demonstrate how this nexus behaves during high and low inflation regimes and turbulent times.

Design/methodology/approach

We employ the panel Autoregressive Distributed Lag (PARDL) technique to examine the nexus between housing affordability in order to capture the distinct characteristics of our sample countries and estimate various short-run and long-run dynamics in the relationship between housing affordability and exchange rate.

Findings

Exchange rate appreciation improves housing affordability in the short run, while this connection tends to dissipate in the long run. Moreover, inflation can worsen housing affordability during turbulent times, like the global financial crisis, in both the short and long run. Ignoring these changes in the relationship between exchange rates and housing affordability during turbulent times can lead to incorrect conclusions.

Originality

The authors are the first to examine the association between exchange rates and housing affordability by demonstrating how these variables behave in high and low inflation regimes and turbulent times.

Keywords: Exchange rate; Housing Affordability; Inflation rate; Global financial crisis; OECD

JEL Codes: A10; R21; R31; F31; E31; B41; C23.

1. Introduction

The need for shelter for people cannot be overemphasized as it constitutes the basic life needs for humans. Abraham Maslow popularised the hierarchy of human needs as detailed in his 1943 seminal paper, *A Theory of Human Motivation*. The theory states that these needs follow each other in succession and priority. The pyramid's base is upon basic, physiological needs, with the need to procure food and shelter on the bottom as the bedrock for humanity's survival. In

the same vein, the provisions and promotions of economic activities serve as one of the compelling duties of government to the citizenry, as this enables and empowers them to carry out economic activities to climb the hierarchical needs further, as stated by Maslow (1943). The essentiality of housing affordability has generated concerns as it seldom entangles itself in opportunity cost with other needs and wants to be desired by individuals, such as education, clothing, and healthcare cum other investment in lieu of housing costs. The rising housing cost infringes on building cost, choice of location, and other macroeconomic fundamentals, including inflation rate, GDP and unemployment rate (see Asal, 2018; Akça, 2023; Coleman, 2008; Kleshcheva, 2021). Variations in housing prices have made housing affordability a nightmare for low-income individuals, making housing affordability one of the most pressing challenges for most cities worldwide (Garriga *et al*., 2020).

The 2014 Indian Institute of Management Bangalore-International Monetary Fund (IIMB-IMF) housing conference pointed out that access to housing finance is a bit easier in developed countries compared to developing countries. The facts from developed countries showed single-digit mortgage rates – Australia: 4.5%, Canada: 2.5-2.9%, Japan: 0.625-0.750%, Norway: 2.2-3.4%, USA: 3.6% – double digits mortgage rates from emerging and developing countries – Namibia: 8.7%, South Africa: 10.5%, Tanzania: 19%, The Gambia: 20-23%, Uganda: 22%, Zambia: 22.5%, and Zimbabwe: 12-18%. The global financial crisis was documented to be premised on the US national subprime mortgage market, as the rapid increase in national house prices before the global crisis is considered the main reason why house prices started to decline between 2007 and 2009 (Aalbers, 2015; Wyly *et al*., 2009), Although, the USA subprime mortgage market has retained much of the public attention since 2007, European countries had also endured several assets inflation linked to the low level of the interest rates since 2001. These make housing affordability an essential issue, as it revolves around increasing income and housing cost disparities.

Over past decades, emerging evidence points towards a significant relationship between critical macroeconomic indicators and fluctuations in housing cost and affordability as the households' incomes increase on nominal as against real scale. Leamer (2015) provides evidence that residential investment has a more considerable impact on output than any other sector and is the best leading indicator of economic activity. By virtue of its prominence as the best early warning sign of an imminent recession, the housing market assumes a prominent role in the conduct of monetary policy by the various countries' monetary authorities. Some scholars argue

that expansionary monetary policy has been significantly responsible for the low level of interest rates and the subsequent house price boom (Bernanke *et al*., 2011; Bordo and Landon-Lane, 2013; Del Negro and Otrok, 2007; Ferrero, 2015). Others contend that a scarcity of financial assets led to capital inflows to developed economies, depressing long rates in government bond markets and stimulating an increase in demand for housing (Favilukis *et al*., 2012; Sa *et al*., 2011). Meanwhile, Condon (2021) and Mah-Hui (2008) maintain that excessive mispricing of risk associated with financial innovation has led to misallocating capital to housing sectors through securitisation, exacerbating the effect of interest rate movements on housing activity. Various studies (including Kleshcheva, 2021; Okkola and Brunelle, 2018; Lim, 2016) have established that economic cycles determine housing affordability while it fluctuates due to changes in macroeconomic indicators such as inflation, unemployment, interest and exchange rates.

The exchange rate – one noteworthy macroeconomic variable – is an essential factor affecting many industries, including real estate and housing affordability (Karadag, 2021; Sumer and Özorhon, 2020). This macroeconomic factor becomes more important for housing affordability, as the attainment of living standards in a country's real estate market to meet international investors' expectations contributes significantly to affordability. This is because economic uncertainty in these countries raises the exchange rate, as an increase in the exchange rate keeps housing prices in the emerging market countries relatively low (Ameziane and Benyacoub, 2022; Choi *et al*., 2023), as foreign investors then take advantage of the low prices to invest in real estate in such economies, leading to economic flooding and reducing the purchasing power and affordability (Ryan-Collins, 2022). The relationship between real estate prices and the exchange rate has always been an important issue mainly because of the concern about the perceived impact of exchange rate fluctuation on prices of general goods and services in import-based economies.

Various arguments have evolved concerning how fluctuating exchange rates can substantially impact domestic businesses' performance and profitability on housing affordability and potential house owners' incomes. For the investor, exchange rate fluctuations pose an exchange risk, as high volatility in exchange rates can lead to considerable losses in an investor's portfolio of investments due to uncertainty of return on investments (Adabre *et al*., 2022; Liu and Lee, 2022; Yusif *et al*., 2023). This is because movements in exchange rates affect the prices of goods on the local and international markets, thereby affecting real estate prices in emerging

market economies (Jack *et al*.,2019; Umoru and Tedunjaiye, 2023). The interest rate is a salient macroeconomic indicator determining the exchange rate and housing affordability. Interest rate plays a role in housing affordability as the higher rate will make borrowing increasingly costly, impacting many facets of personal finances like credit loans and mortgages (Ali *et al*., 2023; Byrne *et al*., 2022; Liu, 2023). A rise in interest rates may mean increased monthly mortgage payments for those holding a variable-rate mortgage, making it more challenging to stick to the budget and fulfil other financial commitments. Among other monetary policy instruments, the interest rate is integral to policy variables coping with unintended exchange rate fluctuations. Despite the conflicting empirical findings, there is a common belief that tight monetary policy and higher interest rates help stabilize exchange rates, although these adversely affect housing affordability. Similarly, exchange rate movements have some implications for inflation dynamics, as an appreciation of the dollar relative to a domestic currency could portend an increase in domestic prices.

Sequel to the above, this study examines the influence of exchange rates on housing affordability in the OECD countries. The exchange rate could impact housing affordability via several channels, including investment and prices. The local housing market may attract foreign investment if the dollar's value rises relative to a domestic currency unit. This impact on housing affordability in the home country could be ambiguous. For instance, if foreigners (foreign investors) control a large portion of the housing market, the appreciation of the dollar relative to the local currency could depict better housing affordability owing to higher investment in the local housing market, which could translate to more housing units. However, if local investors dominate the market, dollar appreciation could portend lower capital for the local investors, thereby restricting their investment in housing and leading to low housing affordability.

On the other hand, if everything else remains the same, an increase in the value of the dollar relative to the local currency will raise local prices, including housing costs/rents, and make housing less affordable. Consequent upon this, we investigate the relationship between inflation and housing affordability, taking a cue from the price channel. Furthermore, the connection between exchange rate and housing affordability is examined for high and low inflation during pre- and post-GFC periods.

As a prelude to our findings, we provide evidence of a positive (sign) relationship between the exchange rate and housing affordability in the long run. However, after a short-term increase in the value of the local (OECD) currency, housing affordability (measured as the housing price-income ratio) decreases (a sign of better affordability). Our long-run outcome is reversed when this nexus accounts for the role of GFC along pre- and post-GFC periods. Moreover, our short-run results are maintained for both pre- and post-GFC eras. Also, higher inflation tends to worsen housing affordability in the OECD countries, albeit in the short run.

Following this introduction, the remainder of this paper is structured thus: Section 2 discusses the data and method employed for this study, while Section 3 presents and discusses the findings from the study. In the final section, Section 4, the paper is concluded.

2. Theoretical Issues

The study is hinged on the purchasing power parity (PPP) theory, founded on the concept of one price, which states that commodity costs are relatively unaffected by exchange rates (Hyrina and Serletis, 2010), as the relationship has significant policy implications due to exchange rate roles in the international markets. By examining the global construction market, perhaps the best approach to describe PPP-adjusted values, according to Langston (2016), is to say that they are local prices expressed in terms of purchasing power, as determined by weighing them in accordance with a typical basket of locally priced construction materials, labour, and machinery. Furthermore, there are differences in housing costs when compared to one another if the PPP-adjusted value is more prominent. Similar to how the USD exchange rate cannot explain every comparable pricing, the relative costs of a specific project cannot be determined by the PPP exchange rate alone. Nonetheless, dividing the local pricing by it produces a comparable international value (Njoroge *et al*., 2019).

The purchasing power parity doctrine, applicable in all monetary situations, offers a reasonable explanation for long-term fluctuations in exchange rates (Chand, 2014). The theory also clarifies how the balance of payments is calculated. However, this theory is not without its limitations (some of these limitations are highlighted in Chand (2014)) and represented in this study for easy reference. First, the notion that exchanges represent relative price levels and that a country's currency is equally valuable domestically and internationally is only valid if it is based on the fallacious assumption that all goods are readily transferable between nations.

Second, tradable products are not necessarily ideal equivalents when produced in various countries. Lastly, the idea ignores how supply and demand affect foreign exchange rates. For instance, even when all other variables are held constant, the price of a housing unit in one nation may change dramatically from that of a similar housing unit in another.

Furthermore, the theory's assumption of free trade and the lack of forex controls for a stable exchange rate is implausible. In actuality, governments impede the free flow of commerce and offer incentives to investors and homebuilders, such as tax holidays and mortgages tailored to their needs. This theory, however, provides an unbiased viewpoint on the connection between foreign exchange rates and residential property performance as it allows for information on the implications of foreign currency rates, providing a neutral platform for conducting a thorough study.

2.1 A brief review of related empirical studies

A number of empirical studies have endeavoured to explore the interactions between house prices and exchange rates by establishing the existence of a cointegration. There are a replete number of empirical studies focusing on the association between exchange rates and house prices (Bahmani-Oskooee and Wu, 2018; Hui *et al*., 2014; Jack *et al*., 2019; Ma and Zhang, 2019; Muzindutsi *et al*., 2021; Ohno and Shimizu, 2015; Qiao and Guo, 2014; Sumer and Özorhon, 2020), inflation and housing price (Al-Masum and Lee, 2019; Coskun *et al*., 2020; Dias and Duarte, 2019; Iacoviello and Neri, 2010; Korkmaz, 2019; Rehman *et al*., 2020; Samimi *et al*., 2008; Tang *et al*., 2019) and how factors like immigration, political and others have influenced housing price (Akça, 2023; Duan *et al*., 2021; Kartal *et al.,* 2023; Kiong and Aralas, 2019; Lee *et al*.,2022; Liu *et al*., 2022; Maynou *et al*.,2021; Muzindutsi *et al*., 2021; Ryan-Collins, 2021; Wang and Hou, 2021; Zhang *et al*., 2012). Some studies focusing on real estate's ability to hedge against exchange rate, interest rate and inflation investigated the correlations between one or a combination of these variables and housing price cum real estate investment. For instance, a study by Goodhart and Hofmann (2008) showed that lower interest rates increase real estate investment, leading to reduced 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.

Due to the increase in the uncertainty caused by the impact of exchange and inflation rates on house prices cum affordability, the duo used to be perceived as having a negative impact on housing (see Akça,2023; Mozaffari and Manochehri, 2023; Ohno and Shimizu, 2015; Qiao and Guo, 2014). However, there are a number of studies suggesting that it is actually the other way around. The earlier studies exploring the nexus between exchange rate and house prices, for instance, Kim and Wang (2023), Sa'ad (2016), Tai *et al*. (2017) and Tripathi (2019) argued that the exchange rate leads to an increase in housing price growth, which will invariably lead to a decline in housing affordability. Meanwhile, Cho (2006), Guo *et al*. (2015), and Kuang and Liu (2015) argued that the rise in inflation results in house price increases, leading to a drop in housing affordability. There are two opinions on the relationship between exchange rates and house prices. According to the first thought, the exchange rate has a positive nexus with house prices (Ferrero, 2015; Jack *et al*., 2019; Tse, 1996; Ya-Chen and Shuai, 2013; Yang and Zhiqiang, 2012). Contrarily, the second perspective suggests a negative relationship between the exchange rate and house prices (Kang and Liu, 2014; Kepili, 2022; Lin *et al*., 2019; Nasir *et al*., 2022).

3. Methodology and Data

3.1 Methodology

This study constructs a Panel Autoregressive Distributed Lag (PARDL) model to examine the relationship between housing affordability and exchange rate in normal and turbulent times as well as across different inflation rate environments. The PARDL model is a panel data variant of the popular time series ARDL model, and it is considered here because of the large time series dimension of our panel data, which makes the issue of unit root a concern. Thus, we first perform the panel unit root tests of different specifications to establish the presence of unit root or a mixed order of integration. In addition, the Panel ARDL model allows us to capture the distinct characteristics of our sample countries and estimate various short-run and long-run dynamics in the relationship between housing affordability and exchange rate, such that different specifications regarding cross-sectional slope coefficients are easily accommodated. The specification of the PARDL is similar to its time series variant, except that some assumptions have to be made on how the short-run and long-run parameters will be estimated. The estimation procedure for the PARDL model is attributable to Pesaran, Shin, and Smith (1997, 1999) and Pesaran and Smith (1995) as these studies formulate the estimation methods for the model, while some useful details regarding the assumptions of these estimators are provided in Blackburne III and Frank (2007). There are essentially two estimators for the

PARDL, namely, the Mean Group (MG), and the Pooled Mean Group (PMG); the former (see Pesaran and Smith (1995)) relies on estimating N time-series regressions and averaging the coefficients, whereas the latter (see Pesaran, Shin, and Smith 1997, 1999) relies on a combination of pooling and averaging of coefficients (see also, Blackburne III and Frank (2007)). Note that regardless of the method used, both the long-run and short-run parameters are estimated. To compare the short- and long-run relationships between housing affordability and exchange rate, the Mean Group (MG) estimator is favoured over the Pooled Mean Group (PMG). The attraction to the former is premised on its flexibility and capacity to account for more heterogeneous dynamics in the slope coefficients.

Since exchange rate movements are caused by several other macroeconomic fundamentals, including inflation, we also opt for the nexus between inflation and housing affordability. For example, a currency depreciation – an indication of weak currency – could push up inflation (and raise interest rates), thereby making houses less affordable. Similarly, the role of the global financial crisis in the nexus is equally examined. Thus, we specify the model for the nexus between exchange rate and housing affordability below.

$$\Delta ha_{it} = \partial_{1i} ha_{i,t-1} + \theta_{1i} + \varphi_{1i} exr_{i,t-1} + \sum_{j=1}^{r} \pi_{1ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{1ij} \Delta exr_{i,t-j} + \varepsilon_{1i} + \nu_{1it} \quad (1)$$

where ha_{it} denotes housing affordability, measured as the ratio of house price to income for the individual country *i* over a specified period *t*; exr_{it} is the explanatory variable which denotes the rate at which a currency is being traded for a dollar; θ_i is the state-specific intercept; Δ indicates the first difference operator; ε_i is for the state-specific effects; and ν_{it} connotes stochastic disturbance term. Furthermore, the short-run impact of the exchange rate on housing affordability is η_{ij}, $-\varphi_{1i} / \partial_{1i}$ measures the long-run effect. Similarly, as mentioned previously, the role of the global financial crisis is also examined for the connection between housing affordability and exchange rate. Thus, we model this as thus.

$$\begin{aligned} \Delta ha_{it} &= \partial_{2i} ha_{i,t-1} + \theta_{2i} + \varphi_{2i}^{pregfc} exr_{i,t-1} * d_t^{pregfc} + \varphi_{2i}^{postgfc} exr_{i,t-1} (1 - d_t^{pregfc}) \\ &+ \sum_{j=1}^{r} \pi_{2ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{2ij}^{pregfc} \Delta exr_{i,t-j} * d_t^{pregfc} + \sum_{j=0}^{s} \eta_{2ij}^{postgfc} \Delta exr_{i,t-j} * (1 - d_t^{pregfc}) + \varepsilon_{2i} + \nu_{2it} \end{aligned} \quad (2)$$

The pre-and post-GFC estimates are differentiated with dummy variables where d_t^{pregfc} is the dummy variable for the pre-GFC and takes the value of one and zero otherwise, and (1- d_t^{pregfc}

) is for the post-GFC. The long- and short-run estimates for the exchange rate are denoted by φ and η, respectively. It should be noted that the differentiation (with serial numbers 1 and 2) in the parameters is common to all the equations, such as $\partial, \theta, \varphi, \pi, \eta, \varepsilon$ and ν are only for easy identification.

To capture the nexus for different inflation dynamics, we specify a model that shows the influence of inflation along low and high inflation rates on housing affordability. This is done along multiple percentiles[4], including 25, 50 and 75. Classification of low and high inflation rates across multiple percentiles allows us to evaluate how the different inflation rate dynamics influence the connection between exchange rates and housing affordability.

$$\begin{aligned}\Delta ha_{it} &= \partial_{3i} ha_{i,t-1} + \theta_{3i} + \varphi_{3i} exr_{i,t-1} \cdot d_t^{low\inf} + \varphi_{3i} exr_{i,t-1}(1 - d_t^{low\inf}) \\ &+ \sum_{j=1}^{r} \pi_{3ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{3ij} \Delta exr_{i,t-j} \cdot d_t^{low\inf} + \sum_{j=0}^{s} \eta_{3ij} \Delta exr_{i,t-1}(1 - d_t^{low\inf}) + \varepsilon_{3i} + \nu_{3it}\end{aligned} \quad (3)$$

As in equation (2) for pre- and post-GFC, we equally employ a dummy to distinguish the impact of low and high inflation rates in the connection between exchange rate and housing affordability. Thus, $d_t^{low\inf}$ is the dummy variable for the low inflation rate, and it is assigned the value of one when it is lower than the average inflation rate over time, and zero otherwise; and $(1 - d_t^{low\inf})$ is for the high inflation rate, which is assigned the value of one when inflation is higher than the average inflation rate.

Finally, to examine the nexus between inflation and housing affordability, as previously enunciated, the procedures involved in the exchange rate are also followed keenly for inflation. Thus, the inflation–housing affordability models are stated as follows.

$$\Delta ha_{it} = \partial_{4i} ha_{i,t-1} + \theta_{4i} + \varphi_{4i} \inf_{i,t-1} + \sum_{j=1}^{r} \pi_{4ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{4ij} \Delta \inf_{i,t-j} + \varepsilon_{4i} + \nu_{4it} \quad (4)$$

$$\begin{aligned}\Delta ha_{it} &= \partial_{5i} ha_{i,t-1} + \theta_{5i} + \varphi_{5i}^{pregfc} \inf_{i,t-1} * d_t^{pregfc} + \varphi_{5i}^{postgfc} \inf_{i,t-1}(1 - d_t^{pregfc}) \\ &+ \sum_{j=1}^{r} \pi_{5ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{5ij}^{pregfc} \Delta \inf_{i,t-j} * d_t^{pregfc} + \sum_{j=0}^{s} \eta_{5ij}^{postgfc} \Delta \inf_{i,t-j} * (1 - d_t^{pregfc}) + \varepsilon_{5i} + \nu_{5it}\end{aligned} \quad (5)$$

$$\begin{aligned}\Delta ha_{it} &= \partial_{6i} ha_{i,t-1} + \theta_{6i} + \varphi_{6i} \inf_{i,t-1} \cdot d_t^{low\inf} + \varphi_{6i} \inf_{i,t-1}(1 - d_t^{low\inf}) \\ &+ \sum_{j=1}^{r} \pi_{6ij} \Delta ha_{i,t-j} + \sum_{j=0}^{s} \eta_{6ij} \Delta \inf_{i,t-j} \cdot d_t^{low\inf} + \sum_{j=0}^{s} \eta_{6ij} \Delta \inf_{i,t-1}(1 - d_t^{low\inf}) + \varepsilon_{6i} + \nu_{6it}\end{aligned} \quad (6)$$

[4] by computing each percentile as $N_i/100 * S$, where N_i is the corresponding percentile, and S is the sample size

3.2. Data

The dataset used in this study consists of the housing price index (HPI), exchange rate and inflation. Our quarterly data cover 1975 through 2022 for all the 18 OECD countries considered. Our choice of countries is anchored on data availability for variables under examination. The housing price index (HPI) – a proxy for housing affordability – is constructed as the nominal house price index divided by the nominal disposable income per head. Similarly, we employ exchange rate and inflation data to explore the relationship between housing affordability and these two variables for the OECD countries. While the exchange rate is measured in terms of the currency of the OECD member countries relative to the US dollar, inflation is computed as a percentage change in the consumer price index. All these data are from the OECD online database.

The subsample inflation attribute for individual OECD countries under study was conducted for a vivid understanding of the rationale for classifying inflation into regimes (see Appendix A). A cursory view shows a downward-slopping 10-year average for these countries, as Figure 1 illustrates the co-movement among the housing price index and exchange and inflation rates in pairs. For instance, Sweden, Spain, New Zealand, Finland, Italy, Ireland, France, and Australia initially experienced double-digit inflation of 10.0%, 16.27%, 13.40%, 10.73%, 15.89%, 13.80%, 10.68%, and 10.31%, respectively from 1975Q1 to 1984Q4 against the single-digit inflation rate recorded in these countries in the succeeding 10-year average computations. Furthermore, the average single-digit – 4.0% – inflation rate reported for the pooled countries became evident in individual countries from 1995Q1 through 2022Q3 (see Appendix A). This observation gave credence to different inflation rate regimes within these countries against aggregate comparison. It should be noted that the lower the value of the house-price ratio, the better it is for such a country, while a lower exchange rate value points to the appreciation of the individual country's currency and vice versa.

From another perspective, high- and low-inflation regimes have been successfully recorded within the countries against low inflation rates reported among the countries via the pooled countries' average (see supplementary Table). Although the stages of the low- and high-inflation regimes differ across the countries, their occurrence is inevitable as none experienced a non-volatile inflation period. Switzerland, the US, Spain, and Italy experienced a smooth and direct switch from a high- to low-inflation rate regime after the first 10-year average – 1974Q1-1985Q4 – as they all witnessed lower inflation afterwards. Meanwhile, countries like Sweden,

Germany, Belgium, and Canada have what we can call a gallop-switch as the regimes alternate from one period to another. For clarity, Sweden recorded a 10% – high inflation regime – inflation rate between 1975Q1 and 1984Q4, which fell to 5.72%, 1.16%, and 1.18% (all these are low-inflation regime) between 1985Q1-1994Q4, 1995Q1-2004Q4 and 2005Q1-2014Q4, respectively, showing a smooth switch but jump to 2.18% between 2015Q1-2022Q3 (see Figure 1 and supplementary Table).

Finally, to formally introduce the relationship between housing affordability (proxied with HPI) and exchange and inflation rates, Figure 1 below captures the co-movement between these variables during the analysis period. The trend shows that at some point, the housing price index and inflation move in the same direction, suggesting higher inflation for housing prices. However, the exchange rate seems to be mixed. Thus, the relationships between these variables are subjected to further empirical validation.

< Insert Figure 1 >

Furthermore, as presented in Table I, a panel unit root test is carried out for the model's variables as a pre-requisite for choosing an empirical model involving large N and T panels. We consider the stationarity test (see Hadri, 2000), nonstationary tests (see Harris and Tzavalis, 1999; Breitung, 2000; Levin, Lin and Chu, 2002; Im *et al*., 1997), and ADF Fisher tests. The unit root test results for Harris and Tzavalis (rho) and ADF Fisher are mixed – [I(0) and I(1)] – while LLC, IPS, and Pesaran CD tests are integrated of order zero[I(0)], with Breitung test integrated of order one [I(1)]. Since the underlying framework for estimation allows for the combination of both I(0) and I(1), in so far as the level of stationarity does not exceed I(1); thus, the mixed order of integration for certain variables in the model is not expected to bias our estimates.

< Insert Table I >

4. Results and Discussion

4.1 Housing affordability and exchange rate

The relationship between housing affordability and the exchange rate is examined following the panel ARDL approach that allows for short- and long-run in the nexus. This relationship is examined for the pre- and post-GFC periods, given the role of the crisis in the housing market. Since movements in exchange rates have some implications for both domestic and foreign prices, we further examine the housing affordability – exchange rate nexus along different inflation dynamics, including low and high inflation rates. This is

done to evaluate how the different inflation dynamics influence the connection between housing affordability and exchange rate. It is important to point out that the influence of the exchange rate on housing affordability could stem from two different channels: investment and price.

Meanwhile, we expect the appreciation of the United States dollar against individual local currencies in the OECD countries to spur foreign investment in the local housing market. This implication on housing affordability in the domestic country may be somewhat mixed. Suppose the housing market is dominated by foreigners (foreign investment). In that case, we expect the dollar's appreciation relative to the local currency to depict better housing affordability owing to higher investment in the local (OECD) housing market, which could translate to more housing units. However, if local investors dominate the market, dollar appreciation could portend lower capital for them (the local investors), thereby reducing their investment in housing. The attendant impact of this would be higher housing prices and, subsequently, lower (worsening) housing affordability in the local economy.

On the contrary, in the instance of the former (where foreign investors dominate the market), dollar depreciation would impact housing affordability (in the OECD countries) negatively/badly, while the opposite (better affordability) would be the case for the economy if the local investors dominate the market. On the other hand, the appreciation of the dollar relative to domestic currency, all things being equal, raises local prices, including housing prices and makes housing less affordable. On the contrary, the depreciation of the US dollar relative to the local currency reduces local prices, which extends to housing prices and, consequently, better housing affordability. In any case, the study only makes a case for the price channel in this study.

From Table II, Panel A, our result shows a positive nexus between exchange rate and housing affordability in the long run. In the short run, however, the exchange rate impacts housing affordability negatively. In other words, housing affordability (housing price-income ratio) decreases (an indication of better affordability) following Dollar appreciation in the short run. When this nexus is considered for pre- and post-GFC periods (panel B), the connection between exchange rate and housing affordability diminishes in the long run, while the significant negative relation between the two variables in the short-run is still maintained for pre- and post-GFC eras. From the foregoing, it is evident that exchange rate

dynamics have some implications for inflation. Thus, we offer additional analyses along different inflation rates, including low and high ones. The two inflation rate classifications are further partitioned into various rates captured by different percentiles, such as the 25th, 50th and 75th percentiles (see Panel C). Our results across this different inflation environment emphasise the short-run impact of exchange rates on housing affordability in the OECD countries. This is because the exchange rate's long-run influence on housing affordability is largely insignificant. However, the short-run impact does not only portray Dollar appreciation as a pointer to better housing affordability; the influence is also significant across various sub-samples (full, pre- and post-GFC samples) considered. The study of Akça (2022), who finds that among other macro fundamentals, the exchange rate has a significant short-run influence on housing prices, is consistent with our results. In another similar study, the real effective exchange rate is found to be the most significant determinant of real housing values in Sweden (Asal, 2018).

< Insert Table II here>

4.2. Housing affordability and inflation rate

Moving beyond the results as stated above, we isolate the influence of changes in the general prices (inflation) on housing affordability, other than examining its influence in the nexus between exchange rate and housing affordability, as presented in the previous discussion (and Table II). These results (pre-and post-GFC and low and high inflation rates) are shown in Table III. Since prices of houses/rents are also assigned some weight in the basket of goods and services that constitute CPI, higher house prices are expected to impact household wealth and, by extension, housing affordability. Similarly, typical of any commodity with limited supply, the nexus between housing affordability and inflation could be traced to different factors, including interest rate and income, among other factors. -income, for example, would raise demand for housing/and or rent, increasing house prices and worsening affordability. It should be noted that this scenario is only obtainable when price growth outpaces income growth. Furthermore, from the interest rate channel, an increase in interest rate would make buying houses more difficult, as a higher interest rate raises the cost of mortgages, for instance, and pushes housing prices and/or rent, thus making houses less affordable.

Akin to the above, we examine the nexus between inflation and housing affordability in the OECD countries. Our results show that higher inflation suggests worsening housing affordability in the OECD countries. Put differently, as prices grow larger in the price-to-income ratio (a measure of affordability), the share of housing expenditure in the total budget becomes larger, thereby making houses less affordable. This result only holds significantly in the short run (see Panel A in Table III). In Panel B, where the connection between the two variables is rendered for pre- and post-GFC periods, our results show the long-run result is negative but not significant (indicating better housing affordability) during the pre-GFC. This suggests that no substantial evidence links better housing affordability to inflation in the long run. However, we have enough evidence to submit that the inflation rate makes housing less affordable during the post-GFC era, albeit in the short run. When the inflation rates are further classified into various levels (percentiles), we find evidence of high inflation (25^{th}, 50^{th} and 75^{th} percentiles) being responsible for less housing affordability in the long run during the post-GFC era. Available evidence of better affordability for the full sample and pre-GFC era (in this period – long run) is not sufficient.

On the other hand, there is also significant evidence of inflation (both low and high) influencing housing affordability badly in the short run. However, this significance is stronger for a high inflation rate than a low inflation rate across various levels (percentiles). Our findings align with Coleman's (2008) study, which shows that by the end of 2007, the cost of financing a home purchase in New Zealand was cyclically higher than on average since 1990. Similarly, Kleshcheva (2021) confirms that the inflation rate is among the economic fundamental that impacts housing affordability directly.

<Insert Table III here>

4.3. Additional Analyses involving time-varying Granger causality test

Further to the above analysis, and beyond limiting the estimation of the nexus between exchange rate and inflation and housing affordability to impact analysis, we further validate this nexus by subjecting our analysis to time-varying modelling using a causality testing procedure. Our causality testing procedure is based on the time-varying VAR model of Shi *et al.* (2019, 2020) rather than the standard VAR model. Estimating using the recursive expanding Wald test, we obtain the results presented in Figure 2, which considers the causality test for both exchange and inflation rates for each of the OECD countries

considered. Examining this figure, about 60 per cent of the countries, including Australia, Canada, Denmark, France, Germany, Japan, New Zealand, Norway, Sweden, the UK and the US, show evidence of Granger causality from exchange rate to housing affordability at some point, particularly during the post-GFC period barring New Zealand and the UK. This is also the case for inflation and housing affordability, as inflation granger causes housing affordability in most of the OECD countries. Unlike the case of the exchange rate, where the evidence is more pronounced during the post-GFC, inflation granger causes housing affordability differently among the OECD countries, as some countries, including Belgium, Germany, New Zealand and Spain, show evidence of causality from inflation to housing affordability during the pre-GFC era. The causality behaviour (from the two variables to housing affordability) appears to be time-varying and episodic, which further justifies this time-varying analysis and the consideration of the role of GFC in the previous analyses.

<Insert Figure 2 here>

4.4 Additional Analyses with the BRICS Data

It's important to note that our previous analyses have only considered data from the OECD, which doesn't include other significant economic classifications such as the BRICS. The BRICS consists of five countries - Brazil, Russia, India, China, and South Africa - and we think it's a good choice for robustness because of its economic performance and resilience to shocks. So, we've decided to extend our analysis to include the BRICS and see how it compares to the OECD data. We have provided the results in Tables IV and V. Table IV examines the connection between exchange rate and housing affordability while also analyzing the role of inflation in this relationship. On the other hand, Table V evaluates the impact of inflation on housing affordability across different levels of inflation.

We have found that exchange rates have a significant impact on housing affordability in both the short and long term for the BRICS group, regardless of inflation levels (refer to Table IV). This finding is in contrast to the evidence obtained for the OECD classification, where the connection between exchange rates and housing affordability is only a short-term phenomenon. Therefore, we can conclude that the reaction of housing affordability to movements in the exchange rate reflects the characteristics of the specific economic classifications considered. In our case, the differing outcomes between the OECD and BRICS may be due to differences in their housing markets. For example, in the more developed housing market of the OECD

group, any external shock through the foreign exchange channel does not seem to have a lasting effect, as the impact is only evident in the short term and tends to dissipate over time. However, in the less developed housing market of the BRICS group, the shock impact through the foreign exchange channel tends to have an effect that extends beyond the short term and into the long term. This outcome supports our consideration of a distinct group rather than providing global evidence that suppresses inherent differences between economic classifications, such as those observed in the OECD and BRICS economic classifications.

4.5 Policy Implications 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 growth in income, 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 monetary authority, to acknowledge the influence of exchange rates on the housing market and take necessary steps to mitigate sharp fluctuations. This will not only stabilize the housing market but also have a more profound impact on the economy. For instance, if the domestic currency depreciates relative to the US dollar, foreign investors may want to diversify their investments to less vulnerable assets or even withdraw their investments from countries whose housing markets are more susceptible to external shocks. This action from foreign investors may further destabilize the exchange rate and create uncertainties in the economy due to the spillover effect of the housing market on other markets like the financial market. Therefore, maintaining

stability in the foreign exchange market is crucial for the housing market and the overall health of the economy.

5. Conclusion

The study was birthed to take a cursory look into how the exchange rate has influenced housing affordability in some OECD countries, given divergent views of past literature on how this macroeconomic variable has dictated housing affordability fortune for seekers. To make the study more unique, we studied these effects in two periods – pre- and post-GFC –within a high and low inflation rate environment to identify possible deferring implications inherent in the given bounds. As a result, we investigate the connection between exchange rate and housing affordability in eighteen (18) out of the thirty-eight (38) OECD countries from 1975Q1 to 2022Q4. More importantly, the Panel ARDL, which explains inherent persistence, heterogeneity, and nonlinearity and accounts for both short and long-run relationships, is used to estimate the models.

Our findings reveal crucial facts about exchange rates and housing affordability in pre- and post-GFC environments. First, we find that the exchange rate improves housing affordability across OECD countries in the short run following local currency appreciation. At the same time, the reverse was the case in the long run. When the sample periods are partitioned into pre- and post-GFC, the exchange rate sustained its significant influence on housing affordability in the short run across these classifications, with the long-run nexus upturned but not significant. Similarly, our findings for inflation rate classification emphasize that the exchange rate impacts housing affordability in these OECD countries in the short run.

Similarly, when inflation is isolated on housing affordability, it manifests that higher income would raise demand for housing, increasing house prices and resulting in unaffordability. Further, we established that higher inflation worsened housing affordability in the OECD regions. Finally, we subjected our analysis to time-varying modelling via the causality procedure using the Shi *et al*. (2019, 2020) VAR model. The VAR shows evidence of Granger causality from exchange rate to housing affordability for some countries during the post-GFC; it was during the pre-GFC era that inflation Granger caused housing affordability in some countries.

The above findings imply that exchange rate depreciation against the local currencies of these OECD only benefits the local investors while foreign investors align with the inverse, and inflation destabilizes as well as shrinks the affordability power of the citizens of these OECD countries in the short run.

It is important to extend the study of the relationship between exchange rates and housing affordability to other economic classifications based on exchange rate regimes (fixed, floating, and managed floating), nature of development (developing and fragile states), and regional blocs (Asia-Pacific, Latin America, Africa, etc.). This will give us more insights into the matter. Additionally, it is necessary to control for other important macroeconomic variables such as interest rates. Countries with high interest rates may attract more capital inflows, which could lead to some level of exchange rate stability as compared to countries with low interest rates. Therefore, accounting for the role of interest rate environments in the exchange rate and housing affordability nexus would significantly advance the literature on the subject.

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Table I: Unit Root Tests

Test Method	HPI	Infl	exr
Null Hypothesis: Unit Root with common process			
Harris-Tzavalis [rho]	-80.6854***[b]	-6.0684***[a]	-18.2811***[a]
Breitung [t-stat.]	-15.7410***[b]	-1.3219*[b]	-6.6157***[b]
LLC [t*]	-6.1285***[a]	-5.8631***[a]	-1.6956**[a]
Null Hypothesis: Unit Root with Individual process			
IPS (*W Stat*)	-6.2981***[a]	-5.4062***[a]	-3.0606***[a]
ADF Fisher [Chi-square]	15.4182***[b]	5.7161***[a]	6.3192***[a]
Null Hypothesis: Unit Root with cross-sectional dependence			
Pesaran CD test [z[t-bar]]	-1.746**[a]	-12.474***[a]	-2.883***[a]
Null hypothesis: No unit root with common unit root process			
Hadri [Z-stat.]	502.8598***	299.7071***	-0.6161[b]
Number of Cross-Sections	18	18	18
Number of Periods	192	192	192
Total Number of Observations	3456	3456	3456

Source: Authors' own work

Note: [a] and [b] denote stationarity at level and first difference, respectively, while ***, **, * indicate statistical significance at 1%, 5%, and 10%, respectively.

Table II: Estimation results for exchange rate and housing affordability nexus

Variable	Panel A	Panel B	Panel C								
			25% percentile			50% percentile			75% percentile		
			Full sample	Pre-GFC	Post-GFC	Full sample	Pre-GFC	Post-GFC	Full sample	Pre-GFC	Post-GFC
φ_{1i}^{*}	1.398*										
	(0.806)										
η_{1ij}	-0.0543***										
	(0.0161)										
$\varphi_{2i}^{*,pregfc}$		-13.65									
		(9.997)									
$\varphi_{2i}^{*,postgfc}$		-9.130									
		(12.92)									
η_{2ij}^{pregfc}		-0.0503**									
		(0.0213)									
$\eta_{2ij}^{postgfc}$		-0.0575***									
		(0.0146)									
$\varphi_{3i}^{*,low\inf}$			2.822	5.144	1.489	3.949	-0.763	0.0355	10.57	-2.871	-0.169
			(1.830)	(5.853)	(1.091)	(3.893)	(5.426)	(0.777)	(6.449)	(4.343)	(0.791)
$\varphi_{3i}^{*,high\inf}$			1.243	-3.819	0.386	2.323	6.396	-0.0419	-6.168	12.63	-1.256
			(0.837)	(3.723)	(1.121)	(1.925)	(7.123)	(0.914)	(6.152)	(10.67)	(1.347)
$\eta_{3ij}^{low\inf}$			-0.0521***	-0.0500**	-0.0624***	-0.0482***	-0.0449**	-0.0612***	-0.0633***	-0.0532**	-0.0528***
			(0.0154)	(0.0239)	(0.0183)	(0.0165)	(0.0228)	(0.0162)	(0.0152)	(0.0236)	(0.0157)
$\eta_{3ij}^{high\inf}$			-0.0569***	-0.0450**	-0.0781***	-0.0542***	-0.0452*	-0.0756***	-0.0429***	-0.0205	-0.0721***
			(0.0158)	(0.0228)	(0.0159)	(0.0170)	(0.0236)	(0.0150)	(0.0159)	(0.0277)	(0.0126)
Observation	3,438	3,438	3,438	2,340	1,080	3,438	2,340	1,080	3,438	2,340	1,080

Source: Authors' own work

Note: Panel A captures the influence of exchange rate on housing affordability while Panel B partitioned this influence along pre- and post-GFC periods. In Panel C, the effect of exchange rate on housing affordability is considered along different inflation dynamics, such as low and high inflation rates. We further classified

these (inflation dynamics) along various percentiles. Also, coefficiencts with symbols φ^* and η denote the long run and short run slope coeffeiecients respectively. The former, φ^* is derived as $-\varphi/\partial$ in all the estimated equations.

Table III: Estimation results for inflation rate and housing affordability nexus

Variable	Panel A	Panel B	Panel C								
			25% percentile			50% percentile			75% percentile		
			Full sample	Pre-GFC	Post-GFC	Full sample	Pre-GFC	Post-GFC	Full sample	Pre-GFC	Post-GFC
φ_{4i}^{*}	-1.049 (0.857)										
η_{4ij}	0.0026*** (0.0006)										
$\varphi_{5i}^{*,pregfc}$		-0.972 (0.827)									
$\varphi_{5i}^{*,postgfc}$		2.361 (1.609)									
η_{5ij}^{pregfc}		0.00115 (0.0012)									
$\eta_{5ij}^{postgfc}$		0.0076*** (0.001)									
$\varphi_{6i}^{*,low\inf}$			0.789 (1.030)	0.178 (0.999)	-0.361 (0.314)	-0.147 (0.881)	0.996 (1.488)	0.0088 (0.133)	0.162 (0.310)	0.0359 (0.319)	0.123 (0.0877)
$\varphi_{6i}^{*,high\inf}$			0.107 (0.329)	-0.0113 (0.0598)	0.223** (0.0942)	-0.0951 (0.132)	-0.0015 (0.158)	0.199** (0.0859)	-0.283 (0.210)	-0.0876 (0.0962)	0.168*** (0.0594)
$\eta_{6ij}^{low\inf}$			0.0003 (0.0011)	0.0006 (0.0017)	0.0036 (0.0042)	0.0016* (0.0009)	-0.0002 (0.0016)	0.0062*** (0.0013)	0.0028*** (0.0007)	0.0016 (0.0011)	0.0075*** (0.0010)
$\eta_{6ij}^{high\inf}$			0.0026*** (0.0006)	0.0009 (0.0013)	0.0088*** (0.0011)	0.0025*** (0.0006)	0.0009 (0.0013)	0.0084*** (0.0011)	0.0029*** (0.0007)	0.001 (0.0013)	0.0082*** (0.0011)
Observation	3,438	3,438	3,438	2,340	1,080	3,438	2,340	1,080	3,438	2,340	1,080

Source: Authors' own work

Note: Panel A captures the influence of the inflation rate on housing affordability, while Panel B partitioned this influence along the pre- and post-GFC periods. In Panel C, the effect of the inflation rate on housing affordability is considered along different inflation dynamics, such as low and high inflation rates. We further classified these (inflation dynamics) along various percentiles. Also, coefficiencts with symbols φ^{*} and η denote the long run and short run slope coefficients respectively. The former, φ^{*} is derived as $-\varphi/\partial$ in all the estimated equations.

Table IV: Estimation results for exchange rate and housing affordability nexus [BRICS]

Variable	Panel A	Panel B		
		25% percentile	50% percentile	75% percentile
φ_{1i}	1.482*** (0.328)			
η_{1ij}	0.000625 (0.000631)			
$\varphi_{3i}^{low\inf}$		1.446*** (0.336)	1.417*** (0.328)	1.315*** (0.373)
$\varphi_{3i}^{high\inf}$		1.481*** (0.335)	1.391*** (0.328)	1.299*** (0.379)
$\eta_{3ij}^{low\inf}$		0.0276*** (0.00966)	0.0236*** (0.00881)	0.0218*** (0.00738)
$\eta_{3ij}^{high\inf}$		0.0289*** (0.0101)	0.0255*** (0.00882)	0.0176** (0.00885)
Observation	252	252	252	252

Source: Authors' own work

Note: Panel A captures the influence of exchange rate on housing affordability while in Panel B, the effect of exchange rate on housing affordability is considered along different inflation dynamics, such as low and high inflation rates. We further classified these (inflation dynamics) along various percentiles. Also, coefficiencts with symbols φ^* and η denote the long run and short run slope coefficients respectively. The former, φ^* is derived as $-\varphi/\partial$ in all the estimated equations.

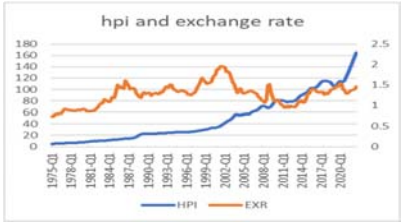
Table V: Estimation results for inflation rate and housing affordability nexus [BRICS]

Variable	Panel A	Panel B		
		25% percentile	50% percentile	75% percentile
φ_{1i}	-0.00369 (0.0403)			
η_{1ij}	0.000892 (0.00124)			
$\varphi_{3i}^{low\inf}$		-7.49e-06 (0.000536)	0.000207 (0.000348)	0.0283 (0.0827)
$\varphi_{3i}^{high\inf}$		4.11e-05 (0.000132)	0.000103 (0.000157)	0.0258 (0.0456)
$\eta_{3ij}^{low\inf}$		0.00104** (0.000484)	0.000602 (0.00106)	0.000996 (0.00179)
$\eta_{3ij}^{high\inf}$		0.000536 (0.00117)	0.000831 (0.00140)	3.65e-05 (0.00101)
Observation	257	257	257	257

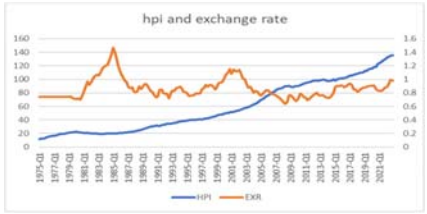
Source: Authors' own work

Note: Panel A captures the influence of the inflation rate on housing affordability, while in Panel B, the effect of the inflation rate on housing affordability is considered along different inflation dynamics, such as low and high inflation rates. We further classified these (inflation dynamics) along various percentiles. Also, coefficiencts with symbols φ^{*} and η denote the long run and short run slope coeffeiecients, respectively. The former, φ^{*} is derived as $-\varphi/\partial$ in all the estimated equations.

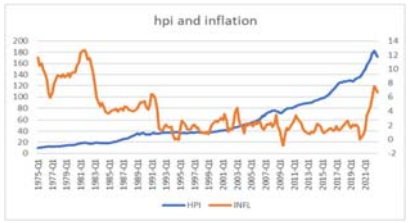
Australia



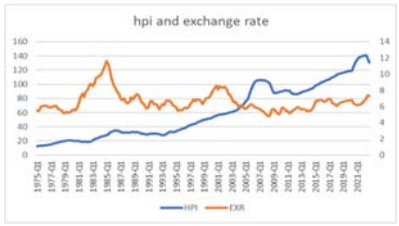
Belgium



Canada



Denmark



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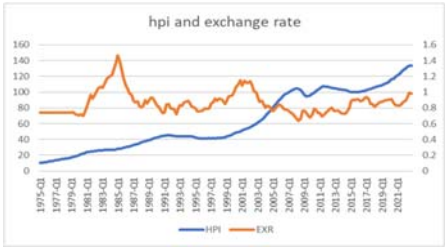

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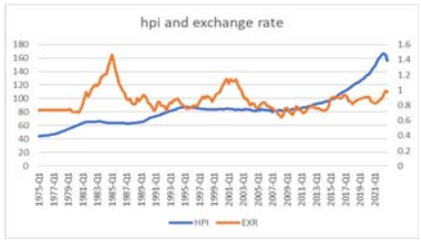

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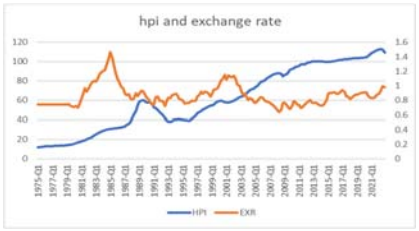
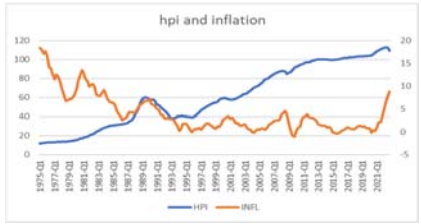
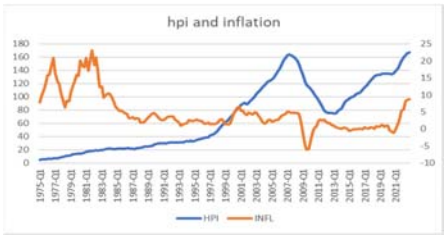
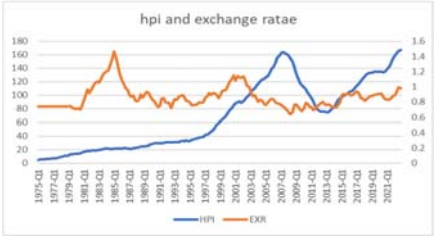




Ireland





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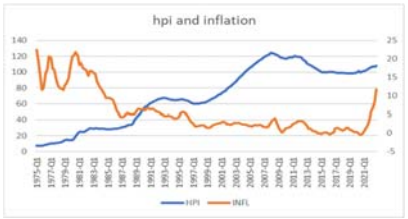

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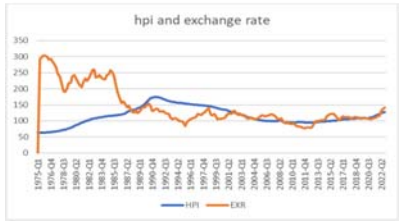
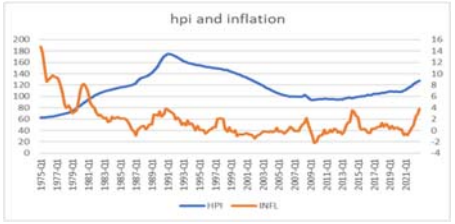
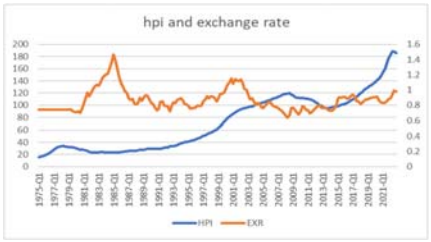




Netherland



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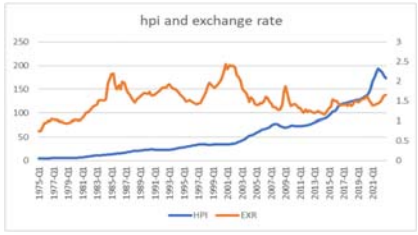
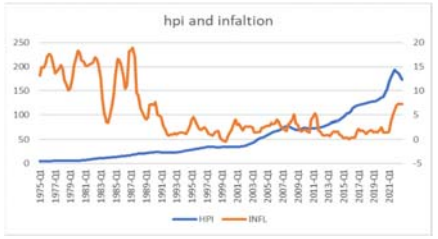
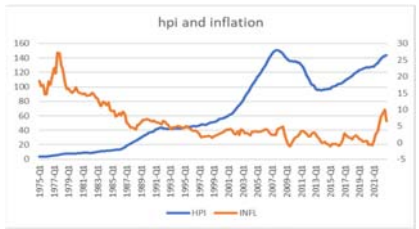
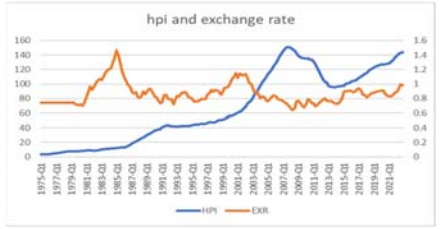




Norway

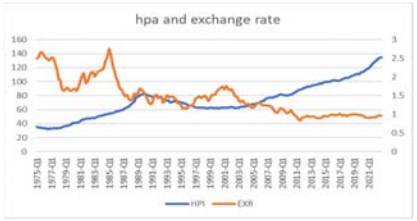
Spain

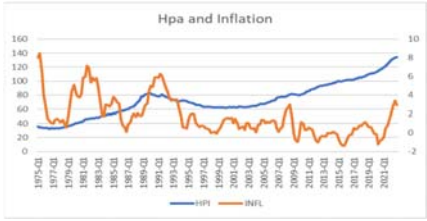




Sweden

Switzerland





UK USA

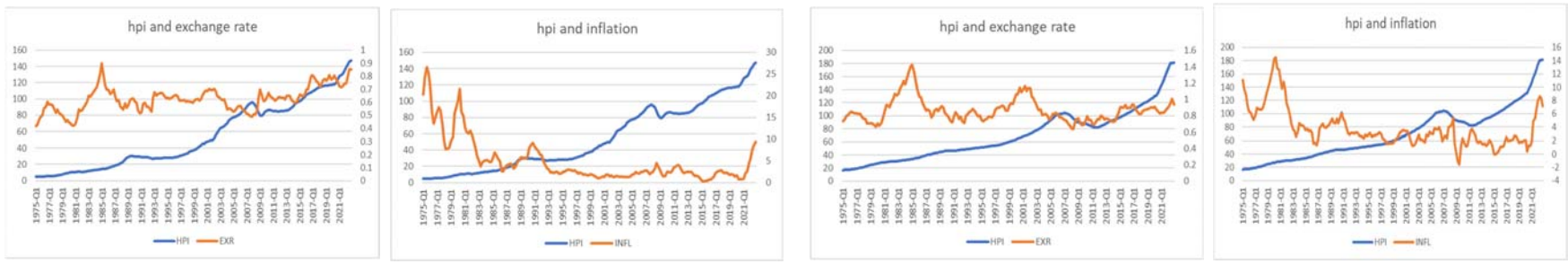
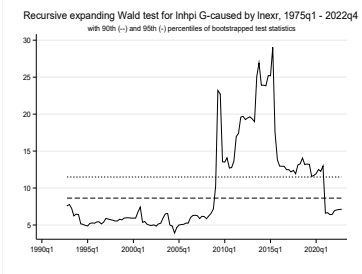


Figure 1: Co-movement between the housing price index and exchange and inflation rates for OECD countries

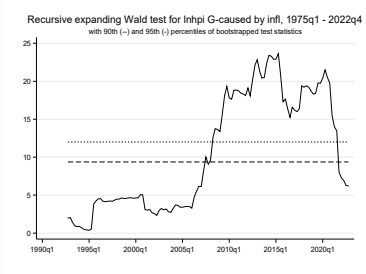
Source: Authors' own work

Australia

Exchange rate and housing

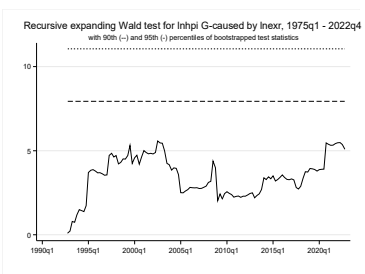


Inflation and housing

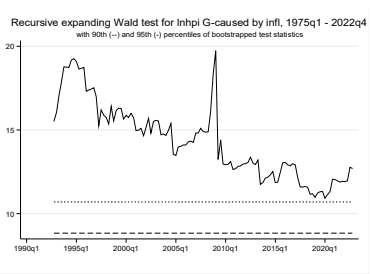


Belgium

Exchange rate and housing

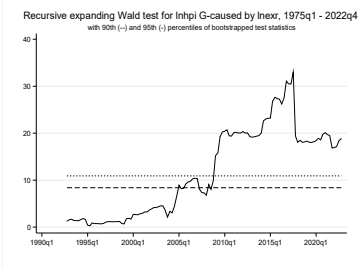


Inflation and housing

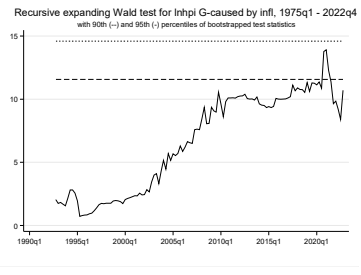


Canada

Exchange rate and housing

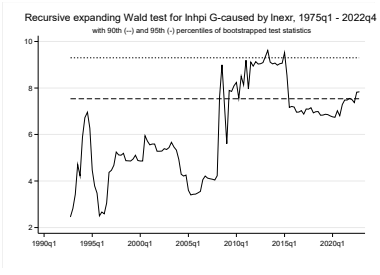


Inflation and housing

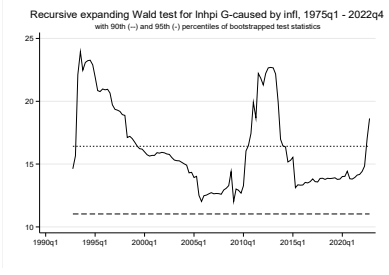


Denmark

Exchange rate and housing

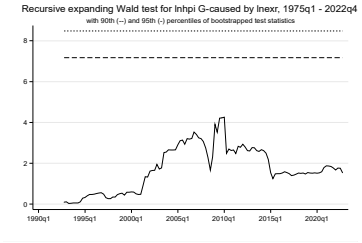


Inflation and housing

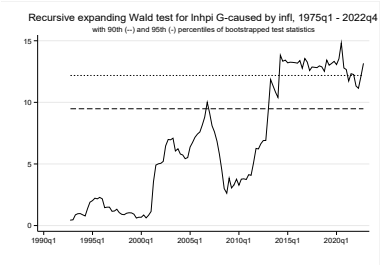


Finland

Exchange rate and housing

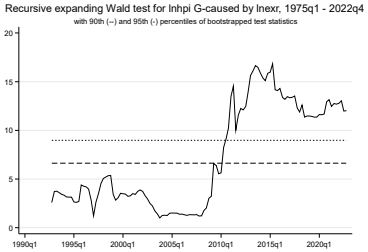


Inflation and housing

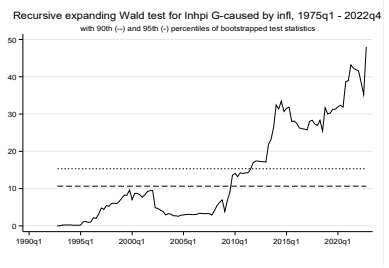


France

Exchange rate and housing

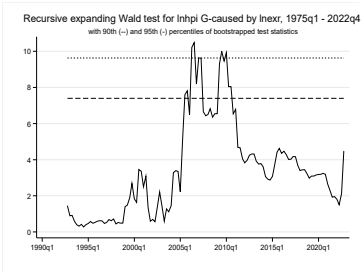


Inflation and housing

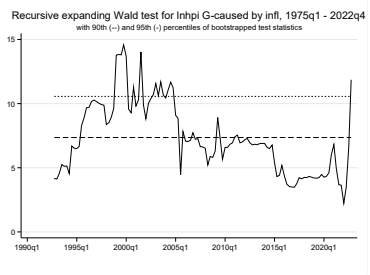


Germany

Exchange rate and housing

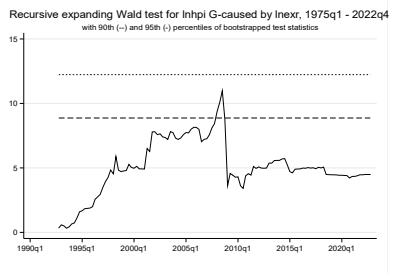


Inflation and housing

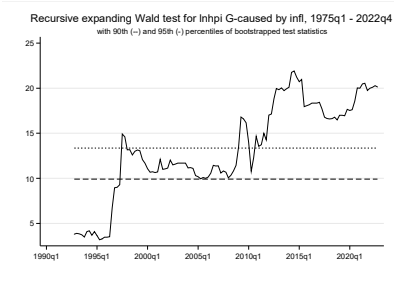


Ireland

Exchange rate and housing

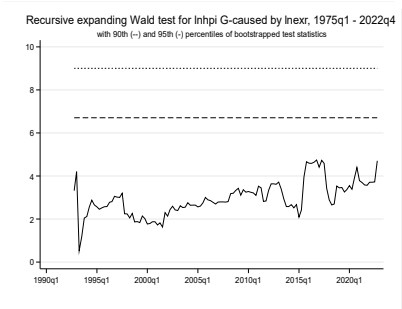


Inflation and housing

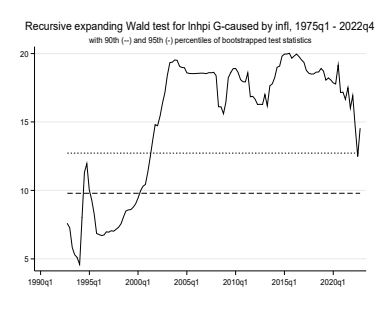


Italy

Exchange rate and housing

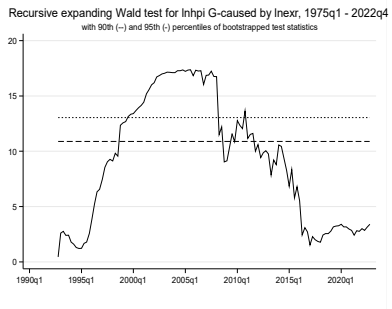


Inflation and housing

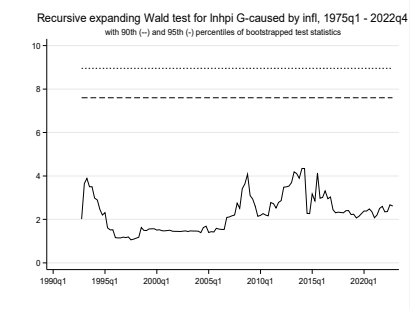


Japan

Exchange rate and housing

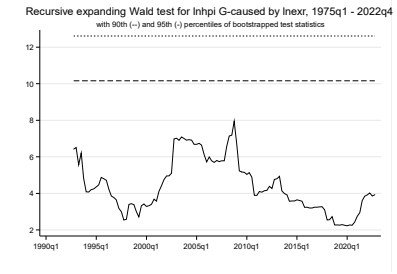


Inflation and housing

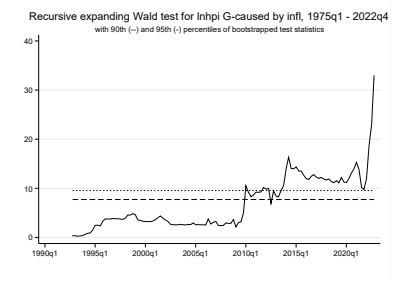


Netherlands

Exchange rate and housing

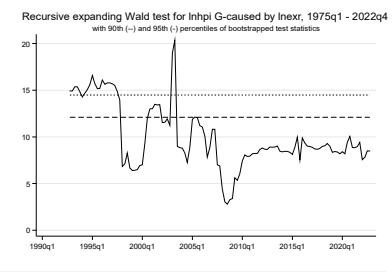


Inflation and housing

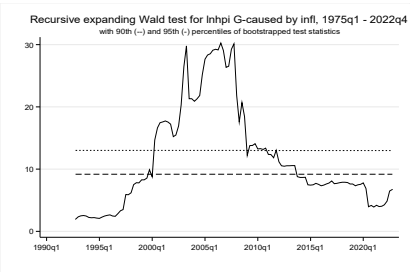


New Zealand

Exchange rate and housing

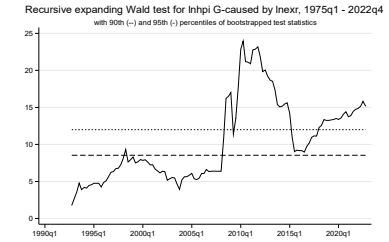


Inflation and housing

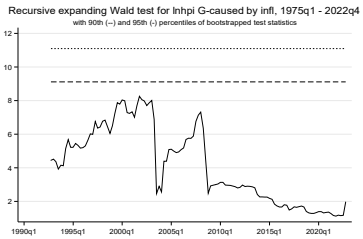


Norway

Exchange rate and housing

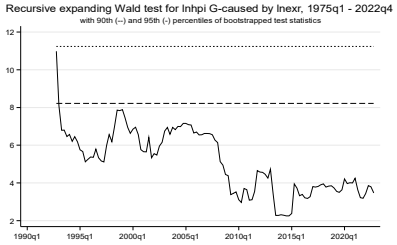


Inflation and housing

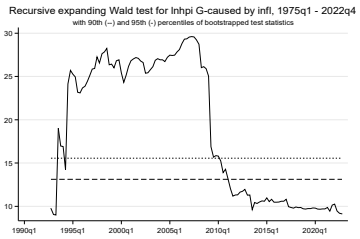


Spain

Exchange rate and housing

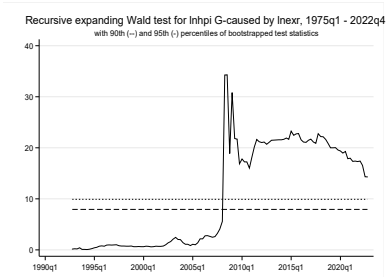


Inflation and housing

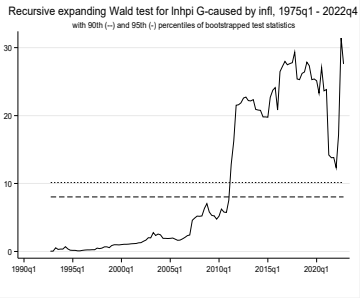


Sweden

Exchange rate and housing

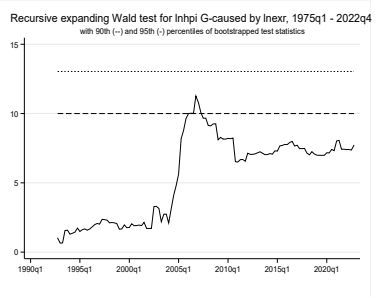


Inflation and housing

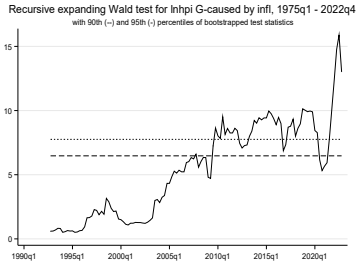


Switzerland

Exchange rate and housing

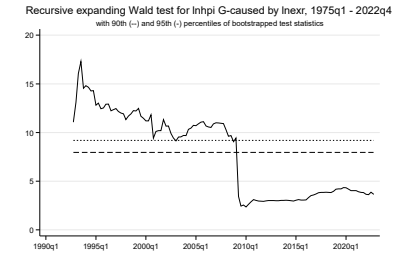


Inflation and housing

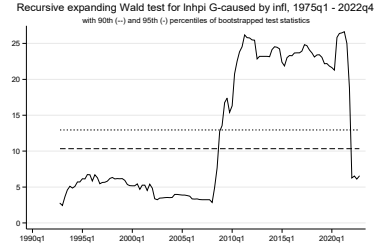


UK

Exchange rate and housing

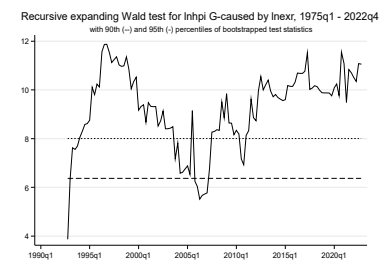


Inflation and housing



US

Exchange rate and housing



Inflation and housing

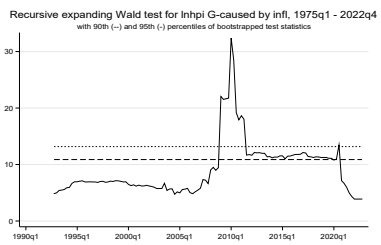


Figure 2: Time-varying causality test for housing affordability granger caused by exchange and inflation rates
Source: Authors' own work

Appendix A

Country	Groupings	Mean	Standard Dev
Switzerland	1975Q1-1984Q4	3.649743	2.174237
	1985Q1-1994Q4	3.011198	1.779693
	1995Q1-2004Q4	0.858955	0.564807
	2005Q1-2014Q4	0.49142	0.966799
	2015Q1-2022Q3	0.368419	1.231015
US	1975Q1-1984Q4	7.788668	3.24054
	1985Q1-1994Q4	3.624938	1.135542
	1995Q1-2004Q4	2.455663	0.672374
	2005Q1-2014Q4	2.293683	1.413872
	2015Q1-2022Q3	2.712925	2.495295
UK	1975Q1-1984Q4	12.65802	6.317725
	1985Q1-1994Q4	4.84587	2.011687
	1995Q1-2004Q4	1.825	0.580782
	2005Q1-2014Q4	2.5	0.76393
	2015Q1-2022Q3	2.421875	2.344896
Netherland	1975Q1-1984Q4	5.90187	2.356257
	1985Q1-1994Q4	1.76586	1.36342
	1995Q1-2004Q4	2.326245	0.820391
	2005Q1-2014Q4	1.764098	0.705585
	2015Q1-2022Q3	2.569925	3.071374
Sweden	1975Q1-1984Q4	10.00821	2.250387
	1985Q1-1994Q4	5.71748	2.739038
	1995Q1-2004Q4	1.161863	1.063882
	2005Q1-2014Q4	1.17629	1.373755
	2015Q1-2022Q3	2.183753	2.664211
Spain	1975Q1-1984Q4	16.27292	3.993511
	1985Q1-1994Q4	6.238768	1.577535
	1995Q1-2004Q4	3.05205	0.914317
	2005Q1-2014Q4	2.218365	1.573522
	2015Q1-2022Q3	1.850684	2.939752
Norway	1975Q1-1984Q4	9.322725	2.747471
	1985Q1-1994Q4	4.641808	2.382634
	1995Q1-2004Q4	2.124885	1.045406
	2005Q1-2014Q4	1.90963	0.976511
	2015Q1-2022Q3	2.881775	1.462543
New Zealand	1975Q1-1984Q4	13.39737	4.039397
	1985Q1-1994Q4	6.94147	5.905122
	1995Q1-2004Q4	2.03558	1.146779
	2005Q1-2014Q4	2.462993	1.269596
	2015Q1-2022Q3	2.353972	2.215693
Finland	1975Q1-1984Q4	10.72793	3.432907
	1985Q1-1994Q4	4.060663	1.788998
	1995Q1-2004Q4	1.34415	0.93598
	2005Q1-2014Q4	1.87077	1.331413
	2015Q1-2022Q3	1.575753	2.320169
Japan	1975Q1-1984Q4	5.6975	3.409247
	1985Q1-1994Q4	1.58416	1.159676

	1995Q1-2004Q4	-0.04833	0.845156
	2005Q1-2014Q4	0.212505	1.2135
	2015Q1-2022Q3	0.60625	1.023573
Italy	1975Q1-1984Q4	15.89136	3.466703
	1985Q1-1994Q4	5.77794	1.455187
	1995Q1-2004Q4	2.758165	1.099111
	2005Q1-2014Q4	1.88437	1.008796
	2015Q1-2022Q3	1.604934	2.778208
Ireland	1975Q1-1984Q4	13.79629	4.677242
	1985Q1-1994Q4	3.200345	1.168598
	1995Q1-2004Q4	3.063243	1.524596
	2005Q1-2014Q4	1.490383	2.819905
	2015Q1-2022Q3	1.414203	2.739739
France	1975Q1-1984Q4	10.67884	2.040323
	1985Q1-1994Q4	3.04108	1.148913
	1995Q1-2004Q4	1.56484	0.605088
	2005Q1-2014Q4	1.478468	0.838185
	2015Q1-2022Q3	1.443513	1.646101
Germany	1975Q1-1984Q4	4.340063	1.395504
	1985Q1-1994Q4	2.522543	1.753761
	1995Q1-2004Q4	1.414098	0.525448
	2005Q1-2014Q4	1.596848	0.736345
	2015Q1-2022Q3	1.971522	2.217356
Belgium	1975Q1-1984Q4	7.49993	2.46869
	1985Q1-1994Q4	2.622228	1.152368
	1995Q1-2004Q4	1.75938	0.626097
	2005Q1-2014Q4	2.086445	1.463367
	2015Q1-2022Q3	2.614659	2.878981
Denmark	1975Q1-1984Q4	9.697278	2.528118
	1985Q1-1994Q4	3.208843	1.3222
	1995Q1-2004Q4	2.163558	0.51461
	2005Q1-2014Q4	1.898138	0.888687
	2015Q1-2022Q3	1.671953	2.470128
Canada	1975Q1-1984Q4	8.793315	2.474736
	1985Q1-1994Q4	3.546265	1.734969
	1995Q1-2004Q4	2.020805	0.841667
	2005Q1-2014Q4	1.808353	0.842768
	2015Q1-2022Q3	2.410303	1.941107
Australia	1975Q1-1984Q4	10.30771	3.211599
	1985Q1-1994Q4	5.43467	3.071197
	1995Q1-2004Q4	2.676985	1.703014
	2005Q1-2014Q4	2.762663	0.861065
	2015Q1-2022Q3	2.141668	1.570366
OECD	1975Q1-2022Q3	3.819435	2.882374

Source: Authors' own work