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Impact of Non-performing Assets and Total ecological footprint on Housing Prices: Panel Evidence from Emerging Economies

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Abstract:

The residential housing market dynamics in emerging economies are influenced by a variety of factors, along with credit risk and environmental deterioration. In this context, this study empirically investigates the influence of banking sector's non-performing loans and total ecological footprint on housing prices for a balanced panel of 13 emerging economies between 2010 to 2020. Before estimating the long-run coefficients, the adopted variables have undergone the necessary panel diagnostic tests including cross-sectional dependence, slope-heterogeneity and panel unit root. Additionally, the Westerlund's cointegration test confirms the existence of a significant long-run equilibrium relationship within the panels. Furthermore, Two-step generalized methods of movement estimation by Arellano-Bover reveals that non-performing assets, ecological footprint, and, real interest rate exert a significant and negative influence on residential housing prices. In contrast, per capita income is positively associated with housing prices, indicating that economic growth ensures a continuous rise in residential property prices in emerging economies. These baseline findings are further confirmed by the PCSE and FGLS estimation techniques. Finally, potential policy implications include addressing credit market uncertainties through appropriate monetary policy and greater thrust for environmental sustainability.

Keywords: Residential housing price; Credit risk; Ecological footprint; Real income; Emerging economy
JEL Codes: R31; E51; Q57; P44

Introduction

Emerging economies experience dramatic upward shifts in the residential housing sector with a high degree of volatility in residential housing prices due to multifaceted factors. In light of this, an imperative task involves the investigation of the drivers contributing to the fluctuations in residential housing prices. This significance emanates from the pivotal role played by the residential housing market in fostering economic growth, generating employment opportunities, and augmenting infrastructure in emerging economies (Rahman, 2008; Mallick, 2011; Innes and Casabianca, 2021; Chen and Chen, 2023). Access to residential housing in emerging economies not only advances the standard of living but also stimulates the mortgage market, thereby enhancing the financial inclusion of individuals (Keys et al., 2012). Further, increasing activity in the residential housing market also boosts the profitability of the banking sector and strengthens the financial sector of the economy (Killins, 2020). Consequently, the stability of the residential housing market is vital.

According to the conventional neo-classical theory, the factors affecting housing prices can be divided into demand-side and supply-side components. The demand-side elements encompass variables such as income and population size (Abraham and Hendershott, 1994; Donald and Winkler, 2002). Conversely, the supply-side determinants comprise factors such as land availability and the quantity of newly constructed residences (Chen et al., 2012). Nevertheless, variables such as interest rates and bank loans exhibit a dual character, concurrently serving as both supply and demand-side determinants. Moreover, the fiscal and monetary policies, the financial systems, actions of speculators in the economy, and expectations of buyers and sellers of houses regarding the housing market are additional factors that affect the residential housing price indirectly (Bengtsson et al., 2017; Glaeser and Gyourko, 2018; Ball, 1994; Yang and Reng, 2021; Mallick and Mahalik, 2012). Adopting a distinct perspective, the contextual intricacies of the residential housing market can be scrutinised through both micro and macro-analyses. Although micro-analysis of the housing market makes data collection concerning house quality and amenities relatively simpler compared to macro analysis (Tiwari and Parikh, 1997), the results of micro-analysis are rarely generalisable to form macro policies. Therefore, the primary focus of this study is on the macro-level analysis of the housing market for emerging economies.

Given the above background, several scholars establish that the role of credit market is inherently essential in influencing the real estate market from both supply and demand side (Kim & Renaud, 2009). In this context, the purchaser involved in the housing market can enter into housing market as investor, consumer as well as a brokers. Over here, every agent who associates with residential housing market massively depends upon the availability of the credit. In this line, in emerging economies major source of credit is supplied by the commercial banks. Given this reason, any disturbances in supply of credit may affect the housing market negatively. Therefore, it is crucial to acknowledge the impact of volatile credit availability due to high volume of non-performing assets (NPA) on residential housing market (Baron & Xiong, 2014). Figure 1 illustrates the increased prevalence of Non-Performing Assets (NPA) in emerging economies, a phenomenon poised to exert notable influence on credit availability, consequently impacting the housing market. This study aims to contribute novel insights to extant research by integrating the pivotal role of banking sector credit risk on residential

housing prices. NPA, recognised as a salient proxy for credit risk, is thus posited as a significant determinant in shaping the housing price dynamics within emerging economies.

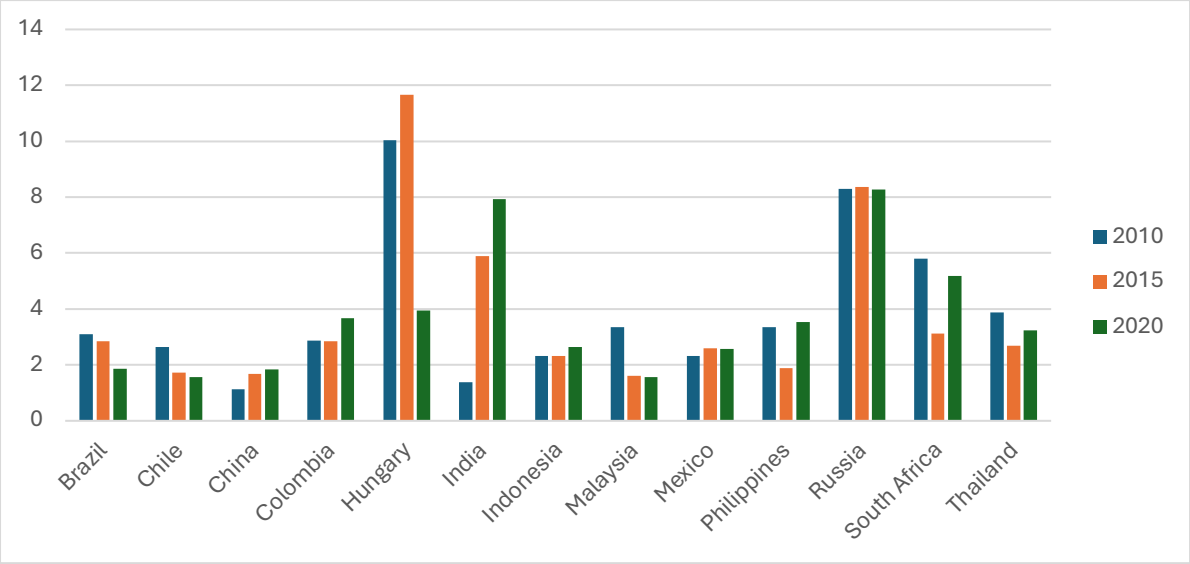

Fig. 1. Trend of non-performing assets in emerging economies
Source: World Development Indicator, World Bank

On the other hand, the contemporary era witnesses an escalation in environmental exploitation, leading to swift climatic alterations that, in turn, reverberate across multiple sectors of the economy. In this regard, scholars have already concluded that environmental pollution in terms of emission of NO_2, SO_2, and PM 2.5 affects the demand for residential housing very significantly (Hao and Zheng, 2017; Dai et al., 2020; Amini, Nafari and Singh, 2022). For example, Wang and Lee (2022) discerned that prospective homebuyers accord paramount importance to favourable air quality conditions when making housing acquisition decisions. The study establishes that environmental pollution stemming from inadequate air quality detrimentally diminishes housing demand, consequently exerting downward pressure on housing prices. Similarly, using pollution index, composed of several pollutants, Das, Chatterjee and Ivaldi, 2022 also confirm that pollution is negatively associated with the housing prices. Furthermore, the detrimental ramifications of water and noise pollution have been observed to exert a significant influence on the dynamics of the housing market (Ge, Huang and Shi, 2024; Morano et al., 2021). Consequently, the environmental context emerges as a pivotal determinant in shaping residential housing prices (Ruijven and Tijm, 2024).

However, a notable limitation of the existing scholarship pertains to the absence of a comprehensive metric for evaluating environmental stress and its ramifications for the housing market. Consequently, this study endeavours to address this gap by conducting an empirical inquiry into the influence of the total ecological footprint on the residential housing market. Total ecological footprint measures the negative impact of humanly activities on the natural environment. It captures the aggregate level of environmental pollution along with Earth's capacity to absorbing it. Moreover, it undertakes an evaluation of the sustainability of anthropogenic activities in relation to the terrestrial ecosystem. The escalating trajectory of the

total ecological footprint, as depicted in Figure 2, signifies an increase in air, water, and soil pollution, thereby detrimentally affecting environmental quality. Given the focus of this study on the residential housing market, each form of pollution assumes equal and consequential importance in perturbing market dynamics. Accordingly, this study introduces total ecological footprint as a climatic determinant that comprehensively elucidates the impact of various forms of pollution on real estate market within emerging economies.

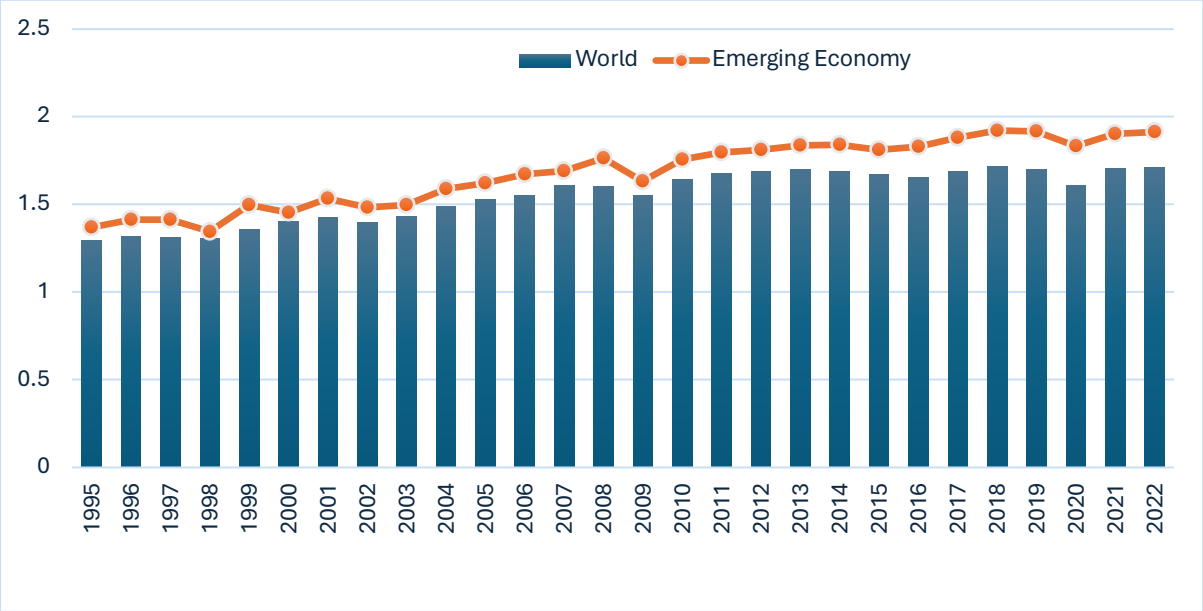

Fig. 2: Trend of Total Ecological Footprint (Number of Earths)
Source: Global Footprint Network

In addition to credit risk and ecological footprint, other factors that have the potential to significantly influence the housing market include per capita income and interest rate. In this context, Mallick and Mahalik (2012) elucidated a strong association between economic growth and the housing market in the emerging economies. Similarly, scholarly investigations have corroborated that the growth rate of national income exhibits a positive and significant correlation with housing prices in emerging economies (Awan & Khan, 2015). Consequently, any fluctuations in real income are intricately linked with variations in residential housing demand (Miller & Peng, 2006). Following this trajectory, Mallick and Mahalik (2015) concluded that an augmentation in real income engenders an upward trajectory in housing demand, subsequently propelling housing prices. The study accentuates the pivotal role of monetary policy set by banks in determining housing prices within emerging economies. In addition to economic growth, interest rate capturing the monetary policy is a critical factor in determining the housing price function (Jin and Zeng, 2004; Beltratti and Morana, 2010; Mahalik and Mallick, 2011). Interest rate represents the cost of borrowing which is inherently connected with the agents associated with the housing markets both from supply and demand side (Kim and Renaud, 2009). Moreover, scholars assert that rise in interest rate spikes up the borrowing costs leading to rise in housing prices and a subsequent decline in the housing demand (Mahalik and Mallick, 2012). As such, per capita income and interest rate have been acknowledged as pivotal factors within the housing market framework. These variables are

therefore incorporated as control variables to elucidate the housing price function in conjunction with evaluating credit risk and ecological footprint.

Research Objectives

Given the aforementioned backdrop, this study delineates the determinants of housing price function into two categories: climatic and non-climatic factors. The total ecological footprint is regarded as a climatic factor, encapsulating aggregate environmental degradation. Conversely, macroeconomic fundamentals unrelated to environmental considerations are classified as non-climatic factors. Specifically, non-climatic factors comprise credit-risk, economic growth, and interest rate. Given the above variable specification, this study empirically investigates the impact of climatic and non-climatic factors on the residential housing market in the emerging economies.

The significance of the study lies in differentiating the factors affecting the housing price as climatic and non-climatic factors. Moreover, this study emphasises the active role of increasing incidence of credit risk as a major non-climatic factor that influence the housing market across emerging economies. Moreover, underscoring the salience of climatic considerations, this study explores the impact of the total ecological footprint on the residential housing market. While prior research predominantly underscores the environmental factor at a micro level, this study introduces a novel dimension by incorporating the total ecological footprint as a macroeconomic variable, thereby capturing the ramifications of environmental degradation on the housing market.

The remaining sections of this study are structured as follows: Section 2 thoroughly evaluates the existing literature surrounding the housing market dynamics and other variables of the study. Section 3 engages in delineating the theoretical background surrounding the direct and indirect dimensions of the housing market. Section 4 provides an overview of the data, methodology, and model specification employed for the estimation of long-run coefficients. Section 5 is devoted to the presentation of the long-run results and the corresponding discussions elucidating these findings. Lastly, Section 6 encapsulates the study's conclusions and articulates the resultant policy implications.

Review of Literature

The existing scholarly discourse has thoroughly investigated the implications of several macro-economic as well as micro-economic factors for housing prices. Within this framework, this study divides the existing literature surrounding housing prices into two categories: First, we explore the intricate relationship between the non-climatic factors and housing prices; Second, we thoroughly scrutinise the existing scholarship surrounding the relationship between climatic factors and housing prices.

Nexus between residential housing price and non-climatic Factors

Non-climatic factors influencing housing prices encompass a diverse range of factors that extend beyond the environmental dimensions. In this context, Scholars concluded that fundamental macro-economic factors along with monetary policy instruments like money

supply and interest rate play crucial roles in determining residential housing prices (Darrat and Glascock, 1989; Mallick and Mahalik, 2015). Using the dynamic equilibrium model of the housing market, Lastrapes (2002) found that money shocks have real effects on housing prices. The study concluded that both real housing prices and housing sales respond positively to the money-supply shocks in the short run. Likewise, Jin and Zeng (2004) concluded that money shocks not only cause the volatility of housing prices but also influence the inconstancy of residential investment. Goodhart and Hofmann (2008) found that there exists multidirectional causality between housing prices, interest rates, and credit availability in 17 industrialised countries. In this context, Kim (1993) concluded that explosive money supply expansion skyrocketed the housing prices in San Jose and Denver between 1982 to 1990. Similarly, Maclennan et al. (1998) confirmed that interest rate fluctuations are transmitted to the overall inflation of the economy through the housing market. Within emerging economies like China and India, Mahalik and Mallick (2011) found that there is a negative relationship between interest rates and housing prices. The study also found that non-food credit availability boosts the demand and therefore the prices for residential housing. Similar conclusions were drawn by Goodhart and Hofmann (2008) for 17 industrialised economies. Furthermore, scholarships also conclude that investment on housing construction activity can be a significant factor that make the housing price sky rocketing (Bangura and Lee, 2020). Beyond monetary variables, other economic factors carry the potential to influence housing prices. Factors like economic growth and urbanization, building costs, and level of employment have a significant association with housing prices (Ball, 1994; Abraham and Hendershott, 1994). Jud and Winkler, (2002) found a positive influence of population growth, real income, and construction costs on housing prices in the USA. Likewise, Mallick and Mahalik (2012) found a bi-directionally causal relationship between real income and housing prices. The study further concluded that real income exerts a positive influence on housing prices.

Extensive literature explores that, unanimously real income exerts a positive influence on housing prices whereas interest rates have a detrimental effect on it. For this reason, real income and interest rates are chosen as control variables in this framework. Although the existing scholarship has thoroughly investigated the role of monetary aggregates, credit availability, and interest rates on housing prices, it has failed to associate credit risk with housing prices. This study therefore tries to empirically fill this research gap by investigating the effect of credit risk on housing prices in emerging economies. This is done by taking non-performing assets (NPA) as a proxy for credit risk.

Nexus between housing prices and climatic factors

The complex interplay between the residential housing market and climatic factors is multifaceted. Within this framework, Hao and Zheng (2017) explored that housing prices are inversely associated with per capita SO2 emissions, industrial soot emissions, and, industrial sewage discharge. Zhen and Chen (2017) found that the emission of PM2.5 creates a negative impact on real estate prices in China. Similarly, Pautrel and Baumont (2013) explored a negative association between property prices and proximity to industrial zones in France. Further, Amini et al. (2022) concluded that housing prices per square meter fall by 0.041% for every 1% rise in the weekly NO2 pollution index and by 0.6%–0.8% for every 10% increase in nitrogen dioxide volume in Iran. Moreover, Zou et al. (2022) found that air pollution has a detrimental effect on housing prices in Shanghai. Moreover, based on discrete choice

approach and hedonic valuation method, existing scholarships clarify the inherent significance of good air quality for the sustainable housing market (Bayer, Keohane, and Timmins, 2009). Specifically, the study also signifies that as one unit reduction of particulate matter concentration raise the value of households by $149 in US metro areas. Furthermore, focusing on 35 major cities in China, Zheng, Kahn, and Liu, (2010) also confirms that ambient air pollution reduces the housing price along with the marginal valuation of green amenities is following a rising trend. Fianlly, using a sample of 115, 732 house sales in California, the study found that as air-quality index improves the willingness to pay for the residential houses increases (Brasington and Hite, 2005; Anselin and Gallo, 2006).

Conversely, Deng et al. (2020) concluded that the demolition of the power plants is linked to an upsurge in prices of 12–14% and a spike in the number purchasing new flats in the surroundings. Similarly, the findings by Yusuf and Resosudarmo (2009) from Jakarta confirm that as the cleanliness of air increases, the market value of it rises from $28 and $85 per $\mu g/m^3$. The above literature depicts that good environmental amenities around the property amplify the willingness of buyers to pay more for it. The study conducted by Chay and Greenstone (2005) control of pollution in non-attainment countries raise the value of residential houses $45 billion.

Beyond environmental factors, the intricacy of ecology wields considerable dominance within the realm of the housing market paradigm. This is because ecological lands offer numerous ecological services, like bettering the condition of the air, lowering stress levels, fostering physical activity, and, raising people's standards of living (Ekkel and Vries, 2017). Ecological lands also help enhance the design of urban development projects and provide unique ecological compensation plans (Liebelt et al., 2018; Wu, 2017). Given the above background, it is clear that ecology may play a very crucial role in the residential housing market dimension. Although the association between the housing market and climatic factors has been thoroughly investigated, few studies focus on the ecological factor as a determining factor of residential housing prices. Given the above background, this study contemplates ecological footprint as an important climatic factor in the formation of housing price functions for emerging economies.

Research gaps

Given the above background, it is quite clear that the existing studies have extensively investigated monetary policy variables and their ramifications on the dynamics of the housing market. However, a notable deficiency in the current body of literature is the limited focus on credit risk, which holds significant potential in shaping the residential housing prices. Additionally, a thorough review of literature pertaining to climatic factors influencing housing prices reveals that while many studies highlight the impact of environmental pollution, the ecological dimension is frequently overlooked. Consequently, this study aims to fill the above research gaps by simultaneously exploring the influences of credit risk and ecological footprint on the residential housing price function.

Theoretical Framework

Given the above background, it is postulated that the housing price function is determined by climatic and non-climatic factors. Among non-climatic factors, monetary policy variables play an important role in deciding housing prices (Darrat and Glascock, 1989; Maclennan et al., 1998; Lastrapes, 2002; Jin and Zeng, 2004; Himmelberg et al., 2005; Goodhart and Hofmann, 2008; Duan et al., 2021). In this context, scholars strongly affirm the inherent association of housing market with the credit market (Magne and Rady, 2006). First, from the supplier's side, for the purpose of construction of houses, it is needed a massive amount of credit requirement. Second from the demand side, as a purchaser there is also required a huge amount of financial support which can be fulfilled by the credit from commercial banks. In this line, the massive expansion of the credit market in emerging markets facilitate high volume of credit transaction along with heightened risk of non-payment of loans (Mishra, Jain and Abid, 2021). Therefore, the risk associated with the credit market may badly influence the credit availability and increase the cost of borrowing. Consequently, high borrowing cost in the credit market hampers the aggregate demand of the residential properties. As a result, reduced demand for housing may convincing the suppliers to supress the price of real estate. In this way, this study presumes that increase in non-performing assets in the banking sector may have negative consequences for the residential property prices.

Furthermore, addressing Rosen's (1974) hedonic price theory it is evidenced that the market value of a property can be influenced by several attributes along with the quality of the environment. Thus, environmental quality plays a crucial role in crafting the residential housing price function. Therefore, this study requires the urgency of incorporating the significance of total ecological footprint as a climatic factor in determining the residential property prices. Here, total ecological footprint implicates the level of environmental degradation of the region by the humanly activities. In this line, it also reflects the magnitude water pollution, air pollution and soil pollution of the given region by the inhabited population of that region. Subsequently, arguments from previous scholarships strongly ensures the detrimental consequences of poor environmental amenities on the residential property prices (Zheng, Kahn, and Liu, 2010; Zou et al., 2022). Therefore, this study hypothesise that total ecological footprint can have the potential harmful effect on the housing price in emerging markets.

Additionally, this study also controls for two other non-climatic factors including per capita income and interest rate. Since residential housing is treated as a normal good, therefore real income can be treated as a strong demand side factor that influences the demand for housing positively. The argument for the positive relation of real income with housing price is also supported by several scholars (Abraham and Hendershott,1994; Mahalik and Mallick, 2011; Mallick and Mahalik, 2012; Fan, Zhou, Yu, and Zhang, 2021). Hence, this study posits that since rise in real income positively stimulates the housing demand, it stimulates an upward pressure on the housing prices. Additionally, this study considers interest rate as a demand side factor, interest rates rise increases borrowing costs, dampening the demand for housing as fewer individuals can afford mortgages. Consequently, this reduced demand exerts downward pressure on housing prices. This phenomenon is particularly pronounced in emerging market economies where economic conditions are more sensitive to changes in

interest rates. Therefore, it is safe to hypothesise that rise in interest rates will likely result in a decrease in housing prices in such economies. Finally, Figure 3 illustrates the expected sign of the explanatory variables of the housing price function.

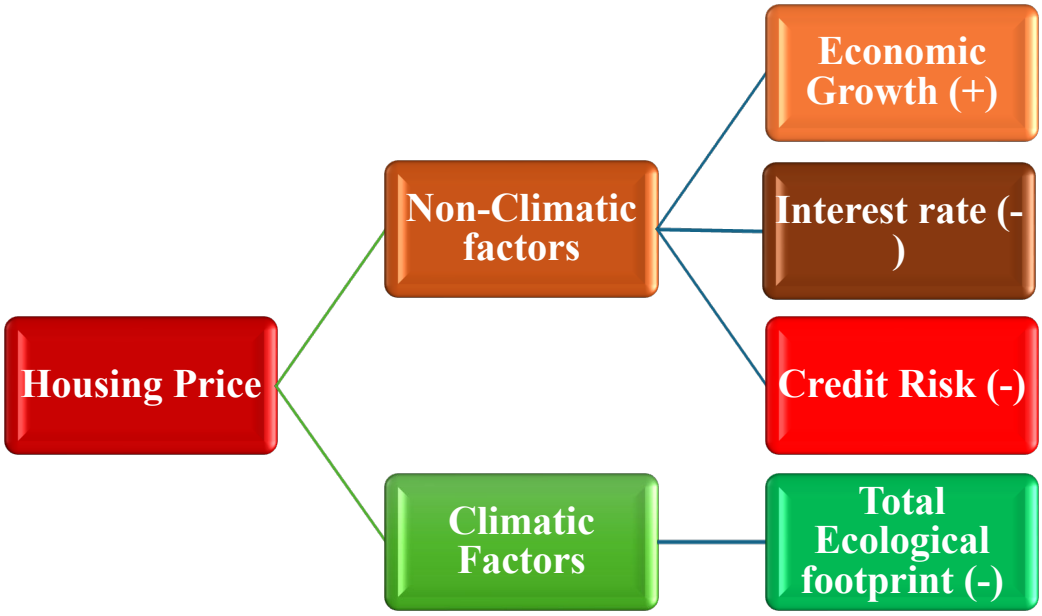

Fig. 3: Sign of the explanatory variables

Data and Methodology

Data

This study uses panel data from 13 emerging economies[1] from 2010 to 2020 to estimate the housing price function. For this the 'Residential Property Price Index' is used as a proxy for capturing housing prices (HP), implying the level of inflation in the residential housing market. To ensure consistency, the monthly and quarterly data about the Residential Property Price Index are converted into annual data, thereby facilitating the maintenance of uniformity throughout the dataset. For gauging the housing price function, this study non-performing assets (NPA) and total ecological footprint (TEF) as the primary explanatory variables. NPA captures the percentage of loans and advances that are not generating any income for the financial institutions. On the other hand, the total ecological footprint is sourced from the Global Footprint Network, encompassing six constituent components: Built-up Land footprint, Carbon footprint, Cropland footprint, Fishing footprint, Forest footprint, and Grazing footprint. The quantification of TEF is expressed in terms of earth equivalents (na). Finally, this study uses GDP per capita and real interest rate as control variables. These variables capture the role of economic growth and monetary policy in the housing price function. Lastly, it is important to note that to make the dataset balanced, we have interpolated the data for the three missing values of non-performing assets and interest rates. A detailed description of the variables along with their data sources is presented in Table 1. Figure 4

[1] Brazil, Chile, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Philippines, Russia, South Africa, and, Thailand

indicates that majority of the selected economies face an inflationary situation in the housing market in emerging economies except Brazil, Indonesia, Russia, and South Africa.

Table 1. Variables adopted and their data sources

Variables' Type	Variables	Specification of Variables	Sources
Dependent variable	HP	Residential Property Price Index	Bank for International Settlements
Treatment variables	NPA	Bank nonperforming loans to total gross loans (%)	World Development Indicators (WDI)
	TEF	Total Ecological Footprint	Global Footprint Network
Control variables	GDP	GDP per capita (constant 2015 US$)	WDI
	RI	Real interest rate (%)	WDI

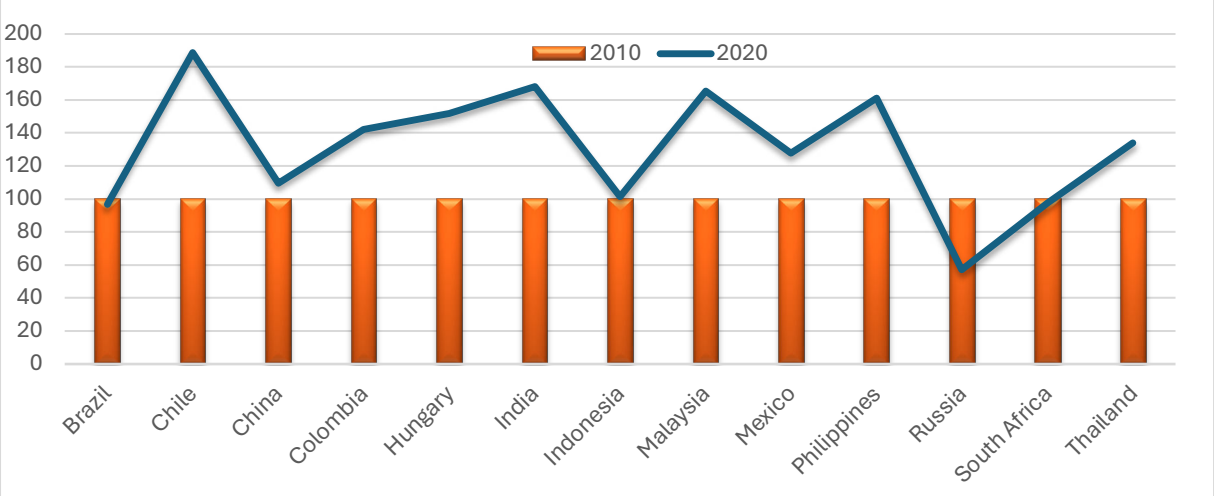

Fig. 4: The trend of Housing prices in Emerging Economies
Source: Bank of International Settlement

Further, Table 2 outlines the descriptive statistics of the variables under consideration. The findings reveal that the average housing price index is 115.491 in the emerging economies between 2010-2020. This suggests that emerging economies face an inflation of over 15% on the housing price which is higher than the overall inflation of these economies. On the other hand, though the mean value of non-performing assets is low, but the difference between the minimum and maximum values is quite high, reflecting that the monetary authority of some countries is more efficient in managing NPA than others. Furthermore, the standard deviation of GDP is the highest among the variables with an average of $7484.382. Additionally, the mean value of the total ecological footprint is 1.832 na, signifying that emerging economies

require an additional 83% of the current land area to align their emissions with the planetary boundaries.

Table 2. Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Min	Max
HP	143	115.491	27.487	52.442	188.738
NPA	143	3.739	3.037	0.953	16.825
TEF	143	1.832	0.829	0.563	3.822
GDP	143	7484.382	3545.762	1238.015	15083.6
RI	143	5.716	8.389	-12.856	41.713

Source: Author's estimation using STATA 17 software version.

Table 3 depicts the results of the pairwise correlation between the variables. The findings substantiate a significant correlation between the primary explanatory variables (i.e. non-performing assets and ecological footprint) and the outcome variable (i.e. housing prices). Unfortunately, the two control variables (i.e. real income and rate of interest) don't show any significant correlation with the housing prices. Consequently, in pursuit of more dependable and consistent inferences, a relevant panel regression analysis is performed in the ensuing sections. The results also suggest that multicollinearity is not going to be an issue, due to insignificant pairwise correlation between the independent variables.

Table 3. Pearson's pairwise correlations

Variables	HP	NPA	TEF	GDP	RI
HP	1.000				
NPA	0.2788*	1.000			
TEF	-0.35**	0.2293	1.000		
GDP	-0.050	0.1092	0.764*	1.000	
RI	0.0197	-0.0705	-0.150***	-0.0083	1.000

Note: *** p < 0.01, **p<0.05, *p<0.1.
Source: Authors' estimation using STATA 17 software version.

Model specification

Given the above background, the housing price function can be represented as

$HP_{it} = f(NCF_{it}, CF_{it}) = f(NPA_{it}, GDP_{it}, RI_{it}, TEF_{it})$ (1)

Following the descriptive statistics from Table 2, the obtained high standard deviation of HP and GDP requires a log transformation that can normalise the distribution which in turn helping in estimating an unbiased result. Henceforth, Equation 2 reform the equation 1 with log transformation of required variables.

$lnHP_{it} = \alpha_0 + \beta_1 NPA_{it} + \beta_2 lnGDP_{it} + \beta_3 RI_{it} + \beta_4 TEF_{it} + \varepsilon_{it}$ (2)

In the above Equation 2, *ln*HP and *ln*GDP represent the logarithmic transformations of housing prices and per capita income, respectively. Besides, NPA, RI, and TEF stand for the residential housing prices, real interest rate, and total ecological footprint respectively. Besides, α_0 represents the intercept, and β_i *(i=1,2,3,4)* are the coefficients of the explanatory variables. Further, ε_{it} captures the stochastic disturbance terms, capturing the influence of the unobserved or omitted variables that could potentially influence the outcome variable. Finally, subscripts *i* and *t* denote cross-sectional units (country) and time period of the study, respectively.

Methodology

Before estimating the housing price function, this study conducts a thorough examination of the data, employing necessary panel diagnostic tests to enhance comprehension and ensure the requisite diagnostic evaluation of the dataset. Firstly, due to the unobserved common factors, panel datasets often exhibit cross-sectional dependence (CD). This unobserved influence subsumed in the error term often leads to potential correlations, violating the Ordinary Least Squares (OLS) assumption of independence of error terms. To account for CD, this study has adopted Pesaran (2004) scaled LM, Baltagi et al. (2012) bias-corrected scaled, Breusch-Pagan (1980) LM CD tests to diagnose the potential issue of cross-sectional dependence. Subsequently, this study uses the Pesaran (2007) cross-sectional augmented I'm Pesaran-Shin (CIPS) unit root test to assess the stationarity properties of the variables of the study. Moreover, as the panel setup is integrated data from several emerging economies, there is every chance of non-existence of slope homogeneity. Henceforth this study proceeds through Blomquist and Westerlund's (2013) slope heterogeneity test as an essential panel diagnosis.

In addition to CD and heterogeneity test, this study has also adopted the second generation cross-sectionally augmented IPS (CIPS) unit-root test for comprehending the stationarity properties of the selected variables. Furthermore, this study goes for the Westerlund's (2005) variance ratio test that is efficient in the presence of cross-sectional dependence, slope heterogeneity, and potential mixed ordered stationarity.

To estimate the influence of the selected explanatory variables on the outcome variable, this study uses the two-step generalized method of moment developed by Arellano and Bover (1995). Since panel data models often counter bi-directional causality, leading to the potential issue of endogeneity, GMM estimation transforms the instrumental variables. As the given estimation uses the first differences of explanatory variables as instrumental variables, it eradicates the problem of endogeneity. In this regard, equation 3 depicts the differenced equation that is suggested by GMM.

$$lnHP_{it} - lnHP_{it-1} = \alpha_0(lnHP_{it-1} - lnHP_{it-2}) + \alpha_1(NPA_{it} - NPA_{it-1}) + \alpha_2(lnGDP_{it} - lnGDP_{it-1}) + \alpha_3(RI_{it} - RI_{it-1}) + \alpha_4(TEF_{it} - TEF_{it-1}) \quad (3)$$

In above equation 3 α_0 illustrates the intercept, and α_i *(i=1,2,3,4)* describes the coefficient of the differenced explanatory variables used in panel dynamic model. Additionally, the subscript i and t depicts the cross-sectional units and time period components respectively. Furthermore, it is robust to heteroscedasticity, autocorrelation, and serial correlation. Besides, this method is preferable when the number of cross-sectional units exceed the time-periods.

Subsequently, Panels corrected standard errors (PCSEs) introduced by Beck and Katz (1995) and the Feasible Generalised Least Square (FGLS) Method (1998) standard errors are used as robust methods to confirm the reliability of the baseline findings. PCSE is appropriate for addressing the issues of serial correlation, cross-sectional dependence, and heteroscedasticity. On the other hand, FGLS estimate address the issue of contemporaneous and temporal correlation among the cross-sections along with problem of cross-sectional dependency. Additionally, the pairwise Dumitrescu and Hurlin's (2012) panel heterogeneous panel causality test is used to enhance the further enhance the robustness of the long-run coefficients.

Empirical Results

Preliminary results

As stated earlier, before estimating the long-run coefficients we have thoroughly diagnosed the selected variables with the relevant panel diagnostic tests to better the properties of the data. Table 4 presents the results for the cross-sectional dependence. The test statistics unanimously reject the null hypothesis of no cross-sectional dependence at 1% level of significance. However, NPA shows no sign of cross-sectional dependence under the Pesaran CD test. Further, Table 5 demonstrates that the existence of slope heterogeneity in the present panel set-up. Moreover, the CIPS unit root test results displayed in Table 6 indicate that all variables, with the exception of the real interest rate, reject the null hypothesis of unit root at the level. Specifically, apart from the real interest rate, all variables exhibit stationarity at the level. Nonetheless, the real interest rate also demonstrates stationarity at the first difference. Finally, Table 7 presents the cointegration results obtained from the Westerlund's (2005) variance-ratio test. All the tests' statistics uniformly reject the null hypothesis of no cointegration among. More specifically, the test statistics reveal a significant long-run relationship between the variables of the study. This helps us to conclude that non-performing assets and ecological footprint along with per capita income and real interest rate has the potential to significantly influence the housing price function.

Table 4. Results of Cross-sectional Dependence

Variables	Breusch – Pagan LM	Pesaran Scaled LM	Bias-corrected scaled LM	Pesaran CD
*ln*HPI	435.53***	28.62***	27.97***	7.74***
NPA	249.70***	13.70***	13.05***	0.13
TEF	243.94***	13.28***	12.62***	7.28***
*ln*GDP	493.66***	33.27***	32.62***	16.34***
RI	212.50***	10.76***	10.11***	6.40***

Note: *** p < 0.01, **p<0.05, *p<0.1.
Source: Authors own estimation from EViews software version 12.

Table 5. Blomquist and Westerlund Heterogeneity test

	Delta
	2.132**
Adj.	3.162***
HAC Kernel	Bartlett
Average bandwidth	1.846
Variables partialled out	Constant

Note: ** p < 0.05 and *** p < 0.01
Source: Authors' estimation using STATA 17 software version.

Table 6. Results of the CIPS panel unit root tests

Variables	CIPS		
	Levels	Δ	Inference
*ln*HP	-2.535**	---	I(0)
NPA	-3.258***	---	I(0)
TEF	-2.635**	---	I(0)
*ln*GDP	-2.848***	---	I(0)
RI	-1.957	-2.302*	I(1)

Note: Δ = first difference operator. ***, **, and * denote 1%, 5%, and 10% levels of significance.
Source: Authors' estimation using STATA software.

Table 7. Westerlund's (2005) test for cointegration

H_0 = No cointegration; H_a = All panels are cointegrated	
	Statistic
Variance ratio	1.467*
Variance ratio (included- panel specific time trend)	3.328***
Variance ratio (Included panel specific time trend & subtract cross-sectional means)	2.558***

Note: ***p < .01 and *p<0.10.
Source: Authors' estimation using STATA 17 software version.

Benchmark results and discussion

Table 7 presents the results obtained from the panel dynamic GMM estimation method. The findings reveal that non-performing assets exert a significant and negative influence on the housing prices of emerging economies. This is because an escalated presence of non-performing assets prompts an elevation in the interest rates Ng'etich (2011), which in turn push the housing demand, thereby causing a contraction in housing prices. Furthermore, the influence of non-performing assets can be transmitted to the housing market through demand and supply channels. In this panel framework, the prevalence of NPA causes the problems of credit constraints as well as the high cost of borrowing, which in turn demotivates the

purchaser in purchasing the houses. In this context, detrimental consequence of prevalence of non-performing assets indicates that the demand side of the housing market dynamics is more vulnerable than the supply side. Additionally, the incidence of non-performing assets also promotes the credit risk which demotivates banking sector to provide loans to its consumer (Thomas and Thakur, 2020). For this reason, the credit constraint pulls the housing prices downward through supressed demand. Finally, the strong association between the liquidity of the banking sector and consumer confidence (Hussein, 2010), amplify the affluence of non-performing assets on the housing market dynamics. In this regard, presence of non-performing assets in the banking sector can erode consumer confidence in the overall economy (Rahman, 2019) which affects the aggregate demand adversely along with demand for housing. Overall, lack of confidence of consumers due to non-performing assets contributes to a slowdown in the real estate market and a decline in housing prices.

Furthermore, the results establish a significant and negative impact of ecological footprint on residential housing price in emerging economies. This confirms a complex interplay between environmental sustainability, economic dynamics, and eventually property prices. Higher ecological footprint amplifies the pollution levels and therefore suppresses the property prices. These results are in line with the findings of (Chen and Wang, 2021; Wang, Wu, and Du, 2022; Zou et al., 2022). This relationship could be attributed to various factors. First, heightened environmental concerns may lead to stricter regulations and policies aimed at curbing ecological degradation. These regulations may impact industries contributing to a higher ecological footprint, potentially affecting economic activities and, subsequently, housing demand. Second, residents and investors in emerging economies may increasingly prioritise sustainable and eco-friendly living, influencing their choices in the real estate market. As a result, properties with lower ecological footprints may be perceived as more valuable, contributing to a decline in housing prices for properties with higher footprints. Additionally, global awareness of environmental issues might attract socially responsible investors who could influence market trends by favouring eco-friendly housing options. These intricate dynamics underscore the importance of considering environmental factors in understanding housing market trends, especially in emerging economies where economic and environmental transitions are ongoing.

Moreover, the estimated results also indicate that real per capita income exerts a positive impact on housing prices. This confirms that spike in per capita income amplifies the demand for housing which in turn reinforces their prices upward in emerging economies. The above result is consistent with the findings of Mallick and Mahalik (2012) and Fan, Zhou, Yu, and Zhang (2021). The increased per capita income may promote the investors for accumulating more assets in terms of purchasing residential properties to get better returns in future. In this context, the role of speculative motive towards the housing market may play a crucial role in amplifying the housing prices in emerging economies (Yang and Rehm, 2021).

Additionally, the results confirm that interest rate rise has a detrimental impact on the housing prices However, the strength of the coefficient is not so strong, implying the transmission of monetary policy operation through interest rate takes a longer period. Further, the appearance of such outcomes might be pertained to the constrained data availability, spanning a comparatively brief timeframe of merely 11 years. This is consistent with the findings of Chen

(2022) who also found a slower transmission of interest rate fluctuation to the real estate market. As such it is fair to conclude that per capita income bears a stronger capacity to influence housing market dynamics compared to the monetary variables in emerging economies.

Table 8. GMM based Arellano-Bover two step estimation

Variables		
	Coefficient	Standard Error
NPA	-0.0116***	0.0016
TEF	-0.0754***	0.0238
*ln*GDP	0.158***	0.0254
RI	-0.0018**	0.0002

Note: *** p<0.01 and ** p<0.05.
Source: Estimations obtained from STATA 17 version software.

Robustness Checks

Finally, this study has adopted PCSE and FGLS robust methods to confirm the reliability of the baseline findings obtained from the GMM estimations. The findings presented in Table 8 confirm the reliability and validity of these baseline findings. More specifically, the results confirm a significant and negative impact of non-performing assets and ecological footprint on the housing price function. On the other hand, the results confirm a positive influence of per capita income on the outcome variable. Finally, though the coefficient of the real interest rate is not significant it also shows a negative influence on the housing prices. This suggests that the monetary policy operation through the interest rate variation may not be an effective instrument for regulation of housing markets in emerging economies. Consequently, policy decisions shaped by the above findings can be formed with an element of certainty.

Table 9. Results from the robustness test

Variables	Panels corrected standard errors (PCSEs)		Regression with FGLS	
	Coefficient	Standard Error	Coefficient	Standard Error
NPA	-0.018***	0.002	-0.018***	0.003
TEF	-0.195***	0.033	-0.195***	0.045
*Ln*GDP	0.138***	0.030	0.138***	0.039
RI	-0.003	0.002	-0.003	0.002
Constant	3.951	0.206	3.951***	0.273

Note: *** p<0.01, ** p<0.05, *p<0.10.
Source: Estimations obtained from STATA 17 version software.

Panel causality

Finally, panel causality results obtained from the Dmitrescu and Hurlin panel causality results are presented in Table 9. The results establish that a bidirectional relationship flows from non-performing assets, ecological footprint, and per capita income to the outcome variable and

vice-versa. Further, a unidirectional causality flows from the real interest rate to the housing prices. This confirms that the residential housing prices are strongly associated with the credit risk of the commercial banks as well the climatic conditions of the economy.

Table 10. Pairwise Dumitrescu and Hurlin (2012) panel heterogeneous causality test results

Null Hypothesis	W-Stat.	Zbar-Stat.
NPA does not homogeneously cause *ln*HP	3.020	2.086**
*ln*HP does not homogeneously cause NPA	6.271	6.272***
TEF does not homogeneously cause *ln*HP	3.846	3.150***
*ln*HP does not homogeneously cause TEF	3.028	2.097**
*ln*GDP does not homogeneously cause *ln*HP	3.682	2.938***
*ln*HP does not homogeneously cause *ln*GDP	2.783	1.781*
RI does not homogeneously cause *ln*HP	8.791	9.517***
*ln*HP does not homogeneously cause RI	0.685	-0.920

Note: *** p<0.01, ** p <0.05, * p<0.10.
Source: Estimations obtained from EViews 12 version software.

Conclusion and Policy Implications

In conclusion, this study fills a very important research gap in the existing literature by simultaneously investigating the influences of non-performing assets and ecological footprint along with other control variables on the housing price function in emerging economies. The results obtained confirm the relevance of credit risk and climatic stress on the housing price dynamics. The results confirm that rise in NPA suppresses the housing prices due to the higher cost of borrowing and the lack of demand. Further rise in ecological footprint supresses the property prices due higher level of pollution and low waste-absorbing capacity of the emerging economies. Furthermore, economic growth boosts the demand for houses which in turn creates a boom in the housing market. Conversely, the results also depict the lesser effectiveness of interest as a monetary policy instrument to regulate the housing market.

The findings of this study accentuate the relevance of a comprehensive intervention of both monetary and fiscal policy tools, which are imperative in maintaining the stability of the housing market. In this regard, the evident negative association between credit risk and housing prices suggests the monetary authorities should craft elegant policies that ensures maintenance of optimum capital adequacy ratio in the banking sector. In this line, central monetary authority should bring such monetary policy that ensures healthy capital-adequate ratio of the commercial banks who largely finance the real estate market. Central banking authorities ought to exercise regulatory oversight over commercial financial institutions through the implementation of the Basel accords, which serve as a prudential framework to mitigate credit risk exposures, thereby fostering stability within the real estate market. Additionally, the relatively muted influence of interest rate provides signals to the monetary authorities to use alternative monetary policy tools to modulate the boom of housing market dynamics.

Moreover, the pronounced detrimental effect of ecological footprint on housing prices underscores the importance of government intervention to alleviate the ecological strain. In this regard, government should advocate better waste management facilities that can

effectively address the mounting ecological burden. Consequently, allocation of a substantial funds by government is very much essential for promotion of the environmentally friendly technologies which in turn mitigate the amplifying stress on ecology. Moreover, to command over pollution, government should extend adequate amount of subsidy to the producers and consumers of clean energy. Furthermore, this suggests that government should properly operate the environmental stringency policy that brings adequate taxation policy for the polluters, so that there would be stability in the housing market. Additionally, government should emphasise upon the proper carbon credit policy which can put strict constraint on the carbon footprint. Finally, such judicious fiscal intervention may be able to facilitate ecological well-being of the economy, which in turn assures the stability in housing market.

Despite offering valuable insights into the ramifications of climatic and non-climatic factors on the housing market in emerging economies, this study has its own limitations. Firstly, the non-inclusion of all emerging market economies classified by MSCI may compromise the generalisability of the findings. Secondly, the temporal scope of the study is confined to11 years, spanning from 2010 to 2020, potentially overlooking the most recent developments influencing the housing market. Moreover, while per capita income and interest rates are treated as control variables, this study may not comprehensively encompass all pertinent factors influencing the housing market in emerging economies. Notably, the study overlooks the heterogeneity in socioeconomic and political attributes among the selected economies. As such, future research should attempt to encompass more countries and extend the temporal horizon to enhance the comprehensiveness and applicability of the findings. Besides, the influence of the recent events such as heightened geopolitical risk, economic uncertainty, and rising corruption should not be ignored when understanding the housing market dynamics.

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