Macroeconomic Determinants of Housing Prices: A Cross Country Level Analysis

Tripathi, Sabyasachi

National Research University Higher School of Economics

19 November 2019

Macroeconomic Determinants of Housing Prices: A Cross Country Level Analysis

Dr. Sabyasachi Tripathi
Postdoctoral Research Fellow
Institute for Statistical Studies and Economics of Knowledge
National Research University Higher School of Economics
20 Myasnitskaya St., 101000, Moscow, Russia
Email: sabya.tripathi@gmail.com

Abstract

The paper investigates the macroeconomic determinants of rising housing prices from a cross country perspective. The random-effect models' analysis suggests that rent, price-to-income ratio, price-to-rent ratio, urbanization, per-capita GDP, inflation, the share of population aged 15-64, GDP growth rate, broad money, and real exchange rate have a positive and statistically significant effect on real house prices. In contrast, the percentage share of employment in services has a negative effect on real house prices. We suggest that government should adjust macroeconomic policies such as inflation, broad money supply, real exchange rate, urbanization, and employment dynamics to control the real house prices.

Keywords: real house prices, macroeconomy, random effect models, cross countries

JEL Classifications: E39, E44, C33

1. Introduction

The housing market is connected with the whole economy of a country. Much economic research and economic policy have evolved around the role of housing prices for macroeconomic policy. The market for housing is widely regarded as being a very important market. Over the five years 2000-2005, estimates by The Economist revealed that the value of residential property in developed countries rose by over 30 trillion dollars - an increase equivalent to 100 percent of those countries combined GDPs. In North America and across Europe, countries have also experienced record highs in terms of house price-to-income ratios [McQuinn and O'Reilly, 2007].[1] The long term interaction between the housing market and macroeconomic variables is done by Leung (2004). The behavior of house prices influences business cycle dynamics and the performance of the financial system. Therefore, activity in the housing market is regarded as a potential indicator of economic performance. The housing market is a source of financial crises and vulnerabilities in the banking sector. Rising housing prices encourage consumer spending and lead to higher economic growth but it affects adversely, by reducing the living standards for those who do not have a house. It is important to note that 35% of the people in the United States (the second largest economy in the world) did not own a house in 2018.[2] Hence, finding the relevant macroeconomic determinants of housing prices is crucial for any macroeconomic policy.

In this context, the present study investigates the appropriate macroeconomic determinants of real house prices for 43 countries in the world for the period of 1970 to 2017. We source data from the Organization for Economic Co-operation and Development (OECD) and the World Bank. The study includes consideration of more variables, more countries, and data ranges then the previous studies. The results are very much important to stabilize housing prices in the context of urbanization, the age structure of the population, price-to-income ratio, price-to-rent ratio, and other important macroeconomic variables such gross domestic product (GDP), exchange rate, inflation rate, etc.

The paper adopts the following structure. The next section reviews the related literature to find out the research gap. The empirical framework and regression results are presented in sections 3 and 4, respectively. The major conclusions and policy implications are made in section 5.

[1] Volume 375, Number 8431, 2005.

[2] The statistics is sourceed from https://www.statista.com/statistics/184902/homeownership-rate-in-the-us-since-2003/, retrieved on 11th November, 2019.

2. Review of literature

The review of literature is mainly divided into three categories, i.e., city level, country level, and cross country level.

2.1 City level:

Belke and Keil (2018) estimated the fundamental determinants of real estate prices of 100 German cities. They found that the supply-side factors of construction activity and housing stock, as well as the demand-side factors of apartment rents, market size, age structure, local infrastructure, and rental prices, are the important determinants of real estate prices. Capozza et al. (2002) explored the dynamics of real house prices by estimating serial correlation and mean reversion coefficients from a panel data set of 62 metro areas in the United States from 1979-1995. The serial correlation and reversion parameters are then shown to vary cross-sectionally with city size, real income growth, population growth, and real construction costs. Serial correlation is higher in metro areas with a higher real income, population growth, and real construction costs.

2.2 Country level

Cohen et al. (2017) evaluated the influence of GDP, unemployment, inflation, interest rate, emigration and the introduction of the means of macroprudential policy on housing prices in Lithuania in the period from 2001 to 2014. The study used the Granger causality test and showed that inflation, interest rate, and emigration are not causal determinants of average housing prices. Tupenaite et al. (2017) estimated the important determinants of housing market fluctuations in Lithuania for the period of 2005- 2015. Research reveals that prices movements in Lithuania's housing sector can largely be explained by economic fundamentals as well as housing market indicators. Xu and Tang (2014) examined determinates of the United Kingdom house prices by applying a cointegration approach and its error correction model based on the quarterly data from 1971Q1 to 2012Q4. The cointegration test concludes that construction cost, credit, GDP, interest rate and unemployment rate have a positive impact on house prices, while disposable income and money supply are negatively correlated with house prices. Panagiotidis and Printzis (2016) examined the role of the housing market in the Greek economy. Using a VECM framework, they found that an equilibrium relationship exists and in the long run the retail sector and mortgage loans emerge as the most important variables for housing. Hossain and Latif (2009) using Generalized Autoregressive Conditional Heteroskedastic (GARCH) and the Vector Autoregressive (VAR) models, they found that housing price volatility is affected significantly by

gross domestic product (GDP) growth rate, housing price appreciation rate and inflation in Canada. Zhang et al. (2012) using Nonlinear Auto Regressive Moving Average with eXogenous inputs (NARMAX) found that most notably mortgage rate, producer price, broad money supply, and real effective exchange rate effect on housing price dynamics in China.

2.3 Cross country level

Égert and Mihaljek (2007) studied the determinants of house prices in eight transition economies of the Central and Eastern Europe (CEE) and 19 OECD countries. They showed that house prices in CEE are determined to a large extent by the underlying conventional fundamentals (i.e., GDP per capita, real interest rates, housing credit, and demographic factors) and some transition-specific factors, in particular, institutional development of housing markets and housing finance and quality effects. Tsatsaronis and Zhu's (2004) a cross country level analysis found that house prices generally depend on inflation, the yield curve and bank credit, but national differences in the mortgage markets also matters. Adams and Füss's (2010) cross-country analysis suggested that house prices to increase in long-run by 0.6% in response to a 1% increase in economic activity while construction costs and the long-term interest rate show average long-term effects of approximately 0.6% and 0.3%, respectively. Glindro et al. (2011) investigated the characteristics of house price dynamics and the role of institutional factors in nine AsiaPacific economies during 1993–2006. On average, house prices tend to be more volatile in markets with lower supply elasticity and a more flexible business environment. At the national level, the current run-up in house prices mainly reflects an adjustment to improved fundamentals rather than speculative housing bubbles.

Vogiazas & Alexiou (2017) found that housing prices depend on the real gross domestic product, bank credit growth, long-term bond yields and real effective exchange rate in the context of seven advanced economies. Algieri (2013) examined the key drivers of real house prices in the five main Euro area countries and the Anglo–Saxon economies from 1970 to 2010. The empirical results indicate that in addition to changes in real income, long-run interest rates, stock prices, and inflation, the latent component has a significant role in explaining real house prices. Zhu (2006) found that with more flexible housing finance markets, house prices are more responsive to overall changes in market conditions, particularly equity price movements in emerging Asian countries. McQuinn and O'Reilly's (2005) theoretical and exercise support the existence of a long-run relationship between actual house prices and the amount individuals can borrow and

they found a plausible and statistically significant adjustment, across countries, to the long-run equilibrium.

3. Empirical framework

After having discussed the potential determinants of real house prices in general terms above, in the following, the panel dataset and the construction of the specific variables, employed in the analysis, are presented. The empirical model and the applied estimation methods are also described.

We use annual data on macroeconomic variables to explain real house prices. The main source for data used in the empirical analysis of this paper is the OECD and the World Bank. We use data for 43 countries from 1970 to 2017.[3]

The following panel data regression model is used for the analysis;

$$\boldsymbol{Real\ house\ price_{it} = \alpha + \mu_{it} + \lambda_{it} + \beta\, X_{it} + \epsilon_{it}} \quad (1)$$

where $Real\ house\ price_{it}$ is the real house prices of country i in year t, $\boldsymbol{\mu_{it}}$ is a country fixed effect (to measure country-specific factors like culture and geography), $\boldsymbol{\lambda_{it}}$ is a year fixed effect (to measure country-invariant time shocks or trends), $\boldsymbol{\epsilon_{it}}$ is a well-behaved error term, $\boldsymbol{X}$ is the vector of the k control variables which measures the macroeconomic factors.

Appendix Table 1 provides the variable definitions and sources of data used for the empirical exercise. The following list gives an overview of the variables capturing the fundamental determinants of real house prices included in our empirical analysis based on the literature review.

- ***Rent***: Based on Belke and Keil (2018), we expect a positive relationship between rents and real house prices, since increasing rents increases the profitability of owning real estate assets.
- ***Per capita GDP and GDP growth rate***: The strong relationship between GDP and the housing market has been examined in several studies. Adams and Füss (2010) noticed that GDP growth has an increasing impact on the housing market. GDP drives real estate markets and is internationally correlated. The strength of those global factors depends on the openness of the country. GDP correlations were found to range, on average, from 0.33 to 0.44 (Case, 2000).

[3] The countries are the following; Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, England, United States, Brazil, Chile, China, Colombia, Estonia, India, Indonesia, Israel, Latvia, Lithuania, Russia, Slovenia, South Africa.

Tsatsaronis and Zhu (2004) using data from 17 industrialized countries and, through variance decomposition, concluded that the long-term contribution of GDP doesn't exceed 10% of the total variation of the housing price. Many studies (Davis and Heathcote, 2005; Iacoviello and Neri, 2010; Goodhart and Hofmann, 2008; Madsen, 2012; Cerutti et al. 2015) agree that a strong short-term relationship exists between the housing market and GDP. Therefore, we expect a positive effect of GDP and its growth rate on the real estate price.

- ***Price-to-income ratio***: The price-to-income ratio is the nominal house price divided by the nominal disposable income per head and it is reflected as a measure of affordability. So a higher the price-to-income ratio indicates a higher housing demand and may increase the house price if the supply of houses does not increase. If the supply of houses increases with the rise in price-to-income ratio, house prices may not increase but do not decrease.
- **Price-to-rent ratio**: The price-to-rent ratio is the nominal house price divided by the rent price and can be considered as a measure of the profitability of house ownership. Therefore, with the same logic as a price-to-income ratio, we expect a positive effect of the price-to-rent ratio on real house prices.
- ***Urbanization***: Urbanization is measured by the percentage of the urban population of a country. Based on Doorn et al. (2019), we expect that urbanization has a positive effect on housing prices as it increases house demand specifically in the urban housing market.
- ***Real interest rate***: When the interest rate rises, the cost of borrowing also rises and potential buyers become discouraged. As a result housing demand falls. On the contrary, when the interest rates decrease, e.g. because of the money supply growth, then the user cost of housing goes down and the demand for housing rises (Apergis and Rezitis, 2003; Igan et al, 2011; Andrews, 2010). Jud and Winkler (2002) and Painter and Redfearn (2002) argued that the influence of houses prices on interest rates is of minor importance while others that the interest rate is one of the most crucial macroeconomic factors of housing (Tsatsaronis and Zhu, 2004; Assenmacher-Wesche and Gerlach, 2008; Iacoviello, 2005; Iacoviello and Pavan, 2011; Goodhart and Hofmann, 2008; Zan and Wang, 2012). Based on these studies, we expect a negative effect of higher interest rates on real house prices.
- ***Inflation***: Follain (1981) and Feldstein (1992) argued that the negative effect of inflation on demand, and on housing investments, while Andrews (2010) detected upward trends of housing prices after a change of inflation in both directions. On the other hand, Nielsen and Sorensen (1994) found that increasing inflation generates housing investment motivation

because of the decreasing real user cost after taxes. All in all, there are discordant views concerning the actual effect of inflation on the housing market (Manchester, 1987; Berkovec and Fullerton, 1989; Madsen, 2012; Apergis and Rezitis, 2003; Tsatsaronis and Zhu, 2004; Bork and Muller, 2012) as it is discussed in Panagiotidis and Printzis (2016).

- ***Employment in services***: Employment and household income are important factors (Lerbs 2011; Giussani et al, 1992; Baffoe-Bonnie, 1998). Schnure (2005) concluded that an unemployment rate percentage increase of one unit leads to a housing price decrease of 1%. Service sector employment is associated with higher income. Therefore, we expect that higher employment in services increases both higher demand f prices.
- **Real exchange rate (RER)**: Pavlova and Rigobon (2007) pointed out that international trade plays an important role in determining the dynamics of countries' asset markets. When a shock causes the home currency to appreciate, then the less favorable terms of trade are going to cause a decline in local asset prices and vice versa. It represents a negative relationship between exchange rates and asset prices with causation running from exchange rates to asset prices. An appreciating RER might be the result of strong inflows of foreign capital in the advanced economies where investment in housing properties is perceived to be a 'safe haven' in periods of uncertainty. Still, an appreciating RER, which signals a loss in competitiveness, could well indicate risks of housing busts or at least, can help explain the occurrence of booms and busts (Martin et al. 2007). Empirical evidence reveals that the real effective exchange rate is positively related to China's house price growth, which implies currency appreciation has a positive effect on house price growth [Zhang et al., 2012].
- **Age**: Population aged 15-64 mainly represents the working population strength of a country. We expect that a larger working-age population causes higher housing prices due to higher demand [Balke and Keil, 2018].
- **Broad money**: Broad money represents the money supply of an economy and it consists of money in any form, including bank or other deposits, as well as notes and coins. Based on Zhang et al. (2012), we also expect that broad money has a positive effect on real house prices.

4. Regression results

To investigate the relevant determinants of real house prices we use the panel data model. Table 1 presents the summary statistics of each variable used in the regression models. The coefficient of variation (CV) measures the dispersions of data points in a data series. Population aged 15-64,

employment in services, real exchange rate, urbanization, and price-to-income ratio have lower values of a CV, which indicates that little differences in their means, implying a more symmetrical distribution. However, it is not the case for inflation, interest rate, GDP growth rate, per-capita GDP and broad money.

Table 1: Descriptive statistics for panel data

Variable	Observations	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation
Real house price (rhp)	1276	80.3	30.9	22.5	175.1	38.5
Rent	1408	61.2	30.9	0.0	133.4	50.4
Price-to-income ratio(pir)	1054	98.1	32.0	48.5	374.7	32.7
Price-to-rent ratio (prr)	1153	88.6	30.5	19.9	188.3	34.4
Urbanization (urban)	2064	69.7	16.0	17.1	98.0	23.0
Per-capita GDP (gdp)	1868	26204.1	19770.7	228.9	111968.4	75.4
Inflation	1878	19.2	116.6	-7.6	2947.7	608.4
Age	2064	65.0	3.9	49.8	73.4	6.0
Interest	748	5.1	8.2	-24.6	77.6	160.4
GDP growth rate (gdpg)	1855	3.3	3.5	-14.8	25.2	106.5
Broad money (broad)	1122	64.2	42.0	9.6	247.9	65.4
Real exchange rate (rer)	1345	100.0	20.0	43.1	270.2	20.0
Employment in services (es)	1161	63.4	12.6	18.7	87.8	19.9

Source: Author

Table 2: Correlation coefficient of the variables used in regression model

	rhp	Rent	pir	prr	urban	gdp	inflation	age	interest	gdpg	broad	rer	es
rhp	1.0												
rent	0.6	1.0											
pir	0.9	0.4	1.0										
prr	0.9	0.5	0.9	1.0									
urban	-0.1	0.0	-0.2	-0.1	1.0								
gdp	-0.1	0.1	-0.2	0.0	0.4	1.0							
inflation	0.1	-0.3	0.1	0.1	-0.2	-0.4	1.0						
age	0.3	0.1	0.3	0.3	-0.1	-0.2	0.1	1.0					
interest	-0.3	-0.4	-0.2	-0.2	0.1	0.1	0.1	0.0	1.0				
gdpg	-0.1	-0.3	0.0	-0.1	0.1	-0.1	-0.1	0.1	0.0	1.0			
broad	0.4	0.5	0.3	0.4	0.2	0.4	-0.4	0.1	-0.2	-0.2	1.0		
rer	0.2	-0.1	0.2	0.2	0.1	0.1	-0.1	0.1	0.2	0.1	0.0	1.0	
es	-0.3	-0.1	-0.4	-0.3	0.3	0.7	-0.2	-0.3	0.0	0.0	0.1	0.0	1.0

Note: See Table 1 for variable definitions. The correlation coefficients are based on 254 observations.
Source: Author.

Table 2 presents the raw correlation coefficients. The estimated values of correlation coefficients quantify the direction and strength of the linear association between the variables. The results show that real house prices have a positive association with a price-to-income ratio, price-to-rent ratio, rent, and broad money. In contrast, real house prices are negatively correlated with an interest rate, employment in services, urbanization, and per-capita GDP.

Tables 3 and 4 present the estimated panel regression models of equation (1). The models are estimated with different specifications and by the number of observations. Regression model 1 reports the full model by considering all the independent variables. Regression models 2-5 represent the parsimonious models by excluding the explanatory variables that do not show statistically significant results due to the collinearity of independent variables. Before we go for choosing the appropriate panel models, we do several diagnostic tests for regression model 1. Table 3 shows the significance of the F-test and compels us to go for the fixed-effect model over the pooled model. The statistically significant value of the Breusch-Pagan Lagrange multiplier (LM) test indicates that the random effect model is appropriate. To decide between random and fixed effect models, we run the Hausman test. The statistically insignificant values of the Hausman test support for estimation of random-effect models. After that, we test for Heteroskedasticity and serial correlation tests for the random effect model of regression 1. The statistically significant value of the Wald test, for group-wise heteroscedasticity, indicates that our regression model suffers from the heteroskedasticity problem. The Wooldridge test for autocorrelation also shows a statistically significant value. Therefore, our regression model also suffers from serial correlation as well. Therefore, to ensure the validity of the regression results, we must obtain robust estimations. To do that, we use the STATA command *xtgls, panels (correlated) corr (ar1)* (the error structure is assumed heteroskedastic with cross-sectional correlation and common AR (1) coefficient for all panels) and obtain feasible generalized least squares regression results. The significant values of the Wald chi^2 statistics for regressions 1–5 indicate that the overall models are statistically significant.

Table 2 : Diagnostic tests for choosing the right panel data model

Diagnostic test	Regression model 1
F-test for model specification. Null hypothesis: Pool versus FE (p-value)	22.66 (0.000)
LM-criteria for model specification. Null hypothesis: Pool versus RE: Pool (p-value)	73.60 (0.000)
Hausman criteria for model specification. Null hypothesis: RE versus FE (p-value)	16.77 (0.1584)
Wald test for groupwise heteroskedasticity: The null is homoskedasticity (p-value)	3.56e+04 (0.000)
Wooldridge test for autocorrelation in panel data: The null is no serial correlation	335.6 (0.000)

Source: *Author's calculation*

Table 4 considers the real house prices as the dependent variable. The regression model 2 shows that rent has positive (as expected) and statistically significant (at 1 % level) effect on real house prices. The coefficient 0.514 indicates that a 10 % increase in rent leads to a 5 % increase in real house prices. Higher rent increases the profitability of owning a real estate asset. The result supports the finding of Belke and Keil (2018). As expected price-to-income ratios also have a strong positive effect (at 1 % level) on real house prices. Price-to-income ratio measures the affordability of owning a house. This indicates that the affordability of owning a house increases real house prices by increasing the demand for a house. Urbanization, which is measured by the percentage of the urban population of a country, has a positive and statistically significant effect on real house prices. A 10% increase in urbanization increases real house prices by about 4%. The higher level of urbanization demands more houses, as it occurs through more rural-urban migration. More people from the rural area come to the urban area and increase the demand for more houses. A higher rate of urbanization in the developing country is experiencing a shortage of supply of affordable houses. The result is very relevant and shows that, higher the urbanization, the higher the real house prices. The result supports Doorn et al. (2019).

The population, aged 15-64, also has a positive and statistically significant (at 10 % level) effect on real house prices. The variable is measured by the total population between the ages 15 to 64 as a percentage of the total population. Larger the working group people indicates less dependency ratio. A higher volume of working-age people means higher income, if they are employed and increases the higher demand for houses. This results in higher real house prices. The result is consistent with Balke and Keil, (2018).

Table 4: Regression results from random-effects model (dependent variable: real house prices)

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Rent	0.392***	0.514***	0.410***		0.707***
	(0.0211)	(0.0256)	(0.0105)		(0.063)
Price-to-income ratio	0.331***	0.745***	0.265***		
	(0.0266)	(0.0188)	(0.0117)		
Price-to-rent ratio	0.582***		0.601***		
	(0.0241)		(0.0127)		
Urbanization	0.0268	0.384***			
	(0.0627)	(0.129)			
Per-capita GDP	-8.58e-05***			0.000674***	
	(2.83e-05)			(7.93e-05)	
Inflation rate	-0.0778	0.0250		0.218***	
	(0.0596)	(0.0616)		(0.0738)	
Age	-0.318**	0.478*		1.960***	
	(0.126)	(0.265)		(0.424)	
Interest rate	-0.00945	-0.0337			-0.0273
	(0.0409)	(0.0506)			(0.0805)
GDP growth rate	0.0299	0.164***	0.0459**	0.177***	
	(0.0372)	(0.0474)	(0.0195)	(0.0576)	
Broad money	-0.00345	0.0204*			0.088***
	(0.00564)	(0.0116)			(0.0247)
Real exchange rate	0.0338***		0.0387***		
	(0.00994)		(0.00878)		
Employment in services	0.0127				- 1.181***
	(0.0788)				(0.198)
Constant	-12.36	-95.49***	-30.67***	-68.89**	101.44***
	(11.84)	(21.40)	(1.332)	(27.66)	(13.17)
Observations	254	361	857	1,272	316
Number of group	15	16	32	43	18
Wald chi^2	10558.42***	2661.55***	17023.19***	130.04***	166.78***

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As expected higher GDP growth rate has a positive effect (at 1% level) on real house prices. The result supports Adams and Füss (2010). Higher economic growth increases the income of the residents of a country and, subsequently increases the demand for houses and, in the process; it increases the real house prices. Broad money has a positive (as expected) and statistically significant effect (at 10 % level) on real house prices. A 10 increase of broad money supply, increases real house prices by about 0.2 %. Broad money supply increases money supply in the

economy and increases the demand for housing and its price. The results support Zhang et al. (2012).

Regression model 3 shows that the price-to-rent ratio has a positive (as expected) and statistically significant (at 1% level) effect on real house prices. A 10% increase in price-to-rent ratio raises real house prices by about 6%. Price-to-rent ratio measures the profitability of house ownership. A higher profitability of house ownership increases the demand for housing and shoots up the real house prices. The real exchange rates have a positive effect on real house prices. The result is statistically significant at 1 % level. Though from a theoretical point of view, a negative effect was expected, [Pavlova and Rigobon, 2007], empirically we got the opposite result. Our result supports the finding of Zhang et al. (2012). In regression model 3, the effect of rent and price-to-income ratio is consistent with the results obtained in regression model 2. However, the significance level of the GDP growth rate has fallen from 1 % in regression model 2 to 10 % in regression model 3.

In regression model 4, per-capita GDP has a positive (as expected) and statistically significant (at 1 % level] effect on real house prices. The result supports the findings of several other studies [Tsatsaronis and Zhu, 2004; Davis and Heathcote, 2003; Iacoviello and Neri, 2008; Goodhart and Hofmann, 2008; Madsen, 2012; Cerutti et al. 2015; Martin et al. 2007]. The inflation rate has a statistically significant [at 1% level] positive effect on real house prices. A 10 percent increase in the inflation rate increases house prices by about 2 percent. This is because a higher rate of inflation indicates a higher money supply in the economy and it increases housing demand and corresponding real house prices. The result is in accordance with Andrews (2010), who detected upward trends of housing prices after the change of inflation in both directions. Finally, though GDP growth rate has a similar effect as in regression models 2 and 3, the significance level of the age variable has increased from 10% in regression model 2 to 1 % in regression model 4.

Lastly, regression model 5 shows that a higher share of employment in the service sector reduces real house prices. The result is statistically significant at 1% level. The coefficient -1.2 indicates that a 1 % increase in employment in services reduces real house prices by 1.2 %. The result runs counter to our expected hypothesis. This could be because of very high income does not increase the demand for housing. The result does not support the findings of Lerbs (2011), Giussani et al. (1992), Baffoe-Bonnie (1998) and Schnure (2005). The effect of rent is consistent with regression models 2 and 3. The significance level of broad money has increased by 10% in the regression

model 2 to 1 % in regression model 5. Surprisingly, the real interest rate does not have any statistically significant effect on real house prices in regression models 2 and 4. This indicates that real house prices do not affect by the real interest rates.

5. Conclusions and policy implications

The paper investigates the macroeconomic determinants of real house prices. Macroeconomic variables are rent prices, price-to-income ratio, price-to rent-ratio, urbanization, per-capita GDP, GDP growth rate, inflation, the population aged 15-64, real interest rate, GDP growth rate, broad money, real exchange rate, and share of employment in services. We consider 43 countries in the world from the period of 1970 to 2017. Data are collected from the World Bank and the OECD. We use random-effect models and feasible generalized least squares regression estimation techniques.

The regression results show that rent, price-to-income ratio, price-to-rent ratio, urbanization (measured by % of urban population), per-capita GDP, inflation, the share of the population aged 15-64, GDP growth rate, broad money, and real exchange rate have a positive and statistically significant effect on real house prices. In contrast, the percentage share of employment in services has a negative effect on real house prices. However, the real interest rate does not have any effect on real house prices.

The results of this analysis suggest that it remains vital for regulators to carefully monitor the real house price market, given its impact on macroeconomic activities. The government should adjust monetary policies such as inflation, broad money supply, and real exchange rate in order to contain the real house prices. The larger working group population aged 15-64 is considered good for a country as they increase the GDP of a country. At the same time, they demand more houses. However, due to higher housing prices sometimes house ownership for young people remains in the dream. Urbanization is required for a county to become developed. King (2017) argued that a third of all urban dwellers worldwide – 1.2 million people- lack access to safe and secure housing. The gap is worst in lower- and middle- income countries. This asks a question about the urbanization and affordability of housing. Therefore, to promote urbanization in most of the developing countries, regulation of real house prices, is essential. Finally, we suggest that overall employment is an important factor to increase the housing demand of a country.

Appendix Table 1: Explanation of variables used in the regression models

Variable	Definition as given by the World Development Indicators, World Bank	Source
Real house prices	In most cases, the nominal house price covers the sale of newly-built and existing dwellings, following the recommendations from RPPI (Residential Property Prices Indices) manual. The real house price is given by the ratio of nominal price to the consumers' expenditure deflator in each country, both seasonally adjusted, from the OECD national accounts database.The real house price is given by the ratio of nominal price to the consumers' expenditure deflator in each country, both seasonally adjusted, from the OECD national accounts database.	OECD (2019), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 01 September 2019)
Rent price	Rent price	OECD (2019), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 01 September 2019)
Price-to-income ratio	The price-to-income ratio is the nominal house price divided by the nominal disposable income per head	OECD (2019), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 01 September 2019)
Price-to-rent ratio	The price-to-rent ratio is the nominal house price divided by the rent price and can be considered as a measure of the profitability of house ownership. This indicator is an index with base year 2015.	OECD (2019), Housing prices (indicator). doi: 10.1787/63008438-en (Accessed on 01 September 2019)
Urban population (% of total population)	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division.	United Nations Population Division. World Urbanization Prospects: 2018 Revision.
GDP per capita (constant 2010 US$)	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2010 U.S. dollars.	World Bank national accounts data, and OECD National Accounts data files.
Inflation, consumer prices (annual	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally	International Monetary Fund, International Financial Statistics and data files.

%)	used.	
Population ages 15-64 (% of total population)	Total population between the ages 15 to 64 as a percentage of the total population. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.	World Bank staff estimates based on age/sex distributions of United Nations Population Division's World Population Prospects: 2019 Revision.
Real interest rate (%)	Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. The terms and conditions attached to lending rates differ by country, however, limiting their comparability.	International Monetary Fund, International Financial Statistics and data files using World Bank data on the GDP deflator.
GDP growth (annual %)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank national accounts data, and OECD National Accounts data files.
Broad money (% of GDP)	Broad money (IFS line 35L..ZK) is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates.
Real effective exchange rate index (2010 = 100)	Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.	International Monetary Fund, International Financial Statistics.
Employment in services (% of total employment) (modeled ILO estimate)	Employment is defined as persons of working age who were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period or not at work due to temporary absence from a job, or to working-time arrangement. The services sector consists of wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services, in accordance with divisions 6-9 (ISIC 2) or categories G-Q (ISIC 3) or categories G-U (ISIC 4).	International Labour Organization, ILOSTAT database. Data retrieved in September 2019

Source: Author's compilation

References

Adams, Z. and R. Füss (2010) "Macroeconomic Determinants of International Housing Markets"**,** *Journal of Housing Economics*, **19**, pp. 38-50

Algieri, B. (2013) "House Price Determinants: Fundamentals and Underlying Factors**"** *Comparative Economic Studies*, **55**, 315-341

Andrews, D. (2010) "Real House Prices in OECD Countries: The Role of Demand Shocks and Structural and Policy Factors, OECD Economics Department Working Papers, No. **831**, OECD Publishing.

Apergis N. and A. Rezitis (2003) "Housing Prices and Macroeconomic Factors in Greece: Prospects within the EMU", *Applied Economics Letters*, **10**, 561 565

Assenmacher-Wesche, K. and S. Gerlach (2008) "Money, Growth, Output gaps and Inflation at Low and High Frequencies: Spectral Estimates for Switzerland", *Journal of Economic Dynamics & Control*, **32**, 411-435.

Baffoe-Bonnie, J. (1998) "The Dynamic Impact of Macroeconomic Aggregates on Housing Prices and Stock of Houses: A National and Regional Analysis", *Journal of Real Estate Finance and Economics,* **17**, 179- 97

Belke, A. and J. Keil (2018) "Fundamental Determinants of Real Estate Prices: A Panel Study of German Regions", *International Advances in Economic Research*, **24**, 25-45.

Berkovec, J. and D. Fullerton (1989) "The General Equilibrium Effects of Inflation on Housing Consumption and Investment", *American Economic Review*, **79**,277-282.

Bork, L. and S. V. Møller, (2002) "Housing Price Forecastability: A factor Analysis", Technical Report, 2012. (School of Economics and Management, University of Aarhus: Copenhagen).

Capozza, D.R., P. H. Hendershott, C. Mack and C. J. Mayer (2002) "Determinants of Real House Price Dynamics", NBER Working Paper. **9262**.

Cerutti, E., J. Dagher and M. G. Dell'ariccia (2015) "Housing Finance and Real-Estate Booms: A CrossCountry Perspective", Staff Discussion Notes, IMF.

Cohen, V. and L. Karpaviciute (2017) "The Analysis of the Determinants of Housing Prices", *Independent Journal of Management and Production*, **8**, 49-63.

Davis, Morris A. and J. Heathcote (2005) "Housing and the Business Cycle", *International Economic Review*, **46**, 751–84.

Doorn, V. L., A. Arnold and E. Rapoport (2019) "In the Age of Cities: The Impact of Urbanisation on House Prices and Affordability", in: Nijskens R., M. Lohuis, P. Hilbers and W. Heeringa (eds) Hot Property. Springer, Cham.

Egert, B. and D. Mihaljek (2007) "Determinants of House Prices in Central and Eastern Europe", Comparative Economic Studies, **49**, 367-388.

Feldstein, M. (1982) "Inflation, Tax Rules and Accumulation of Residential and Non-Residential Capital", *Scandinavian Journal of Economics*, **84**, 293-311.

Follain, J.R. (1981) "Does Inflation Affect Real Behavior? The Case of Housing", *Southern Economic Journal* , **48**, 570-82

Giussani, B., M. Hsai and S. Tsolacos (1992) "A Comparative Analysis of the Major Determinants of Office Rental Values in Europe", *Journal of Property Valuation and Investment* , **11**, 157-173.

Glindro, E.T., S. Tientip, S. Jessica and Z. Haibin (2008) "Determinants of House Prices in Nine Asia-Pacific Economies", Bureau of International Settlements Working Paper no. **263**.

Goodhart, C. and B. Hofmann (2008) "House Prices, Money, Credit, and the Macroeconomy" *Oxford Review of Economic Policy*, **24**, 180-205.

Hossain, B. and E. Latif (2009) "Determinants of Housing Price Volatility in Canada: A Dynamic Analysis", *Applied Economics*, **41**, 3521–31.

Igan, D., A. Kabundi, F. N. D. Simone, M. Pinheiro and N. Tamirisa (2011) Housing, Credit, and Real Activity Cycles: Characteristics and Comovement, *Journal of Housing Economics*,**20**, 210-231

Iacovello, M. (2005) "House Prices, Borrowing Constraints and Monetary Policy in the Business Cycle", *American Economic Review,* **95**, 739-764.

Iacoviello, M. and S. Neri (2010) "Housing Market Spillovers: Evidence From an Estimated DSGE Model, *American Economic Journal: Macroeconomics*, **2**, 125-164.

Iacoviello, M. and M. Pavan (2013) "Housing and Debt over the Life Cycle and over the Business Cycle" *Journal Monetary Economics*, **60**, 221–38.

Jud, D. and D. Winkler (2002) "The Dynamics of Metropolitan Housing Prices", *Journal of Real Estate Research*, **23**, 29-45.

Leung, C. (2004) "Macroeconomics and Housing: A Review of the Literature", *Journal of Housing Economics,* **13**, 249-267.

Madsen, J.B. (2012) "A Behavioural Model of House Prices", *Journal of Economic Behaviour & Organization*, **82**, 21-38.

Manchester, J. (1987) "Inflation and Housing Demand: A New Perspective", *Journal of Urban Economic Literature,* **30**,102-42

McQuinn, K. and G. OReilly (2007) "A Model of Cross-Country House Prices", Central Bank and Financial Services Authority of Ireland Research Technical Paper **5** (July)

Lerbs, O. (2011) "Is There a Link Between Homeownership and Unemployment? Evidence from German Regional Data", *International Economics and Economic Policy*, **8**, 407-426.

Martin, R., L. Schuknecht and I. Vansteenkiste (2007) "The Role of the Exchange Rate for Adjustment in Boom and Bust Episodes. ECB Working Paper 813.

Nielsen, S.B. and P. B. Sorensen (1994) "Inflation, Capital Taxation, and Housing: The Long Run in a Small Open Economy", *Canadian Journal of Economics*, **27**, 198-217.

Panagiotidis, T. and P. Printzis (2016) "On the Macroeconomic Determinants of the Housing Market in Greece: A VECM Approach, *International Economics and Economic Policy*, **13**, 387–409.

Painter, G., & Redfearn, C. (2002).The role of interest rates in influencing long-run home ownership rates. Journal of Real Estate Finance and Economics. No. 25:2/3, 243-267.

Pavlova, A. and R. Rigobon (2007) "Asset Prices and Exchange Rates", *Review of Financial Studies,* **20**, 1139–1180.

Schnure, C. (2005) "Boom-Bust Cycles in Housing: The Changing Role of Financial Structure", IMF Working Paper WP/05/2005.

Tsatsaronis, K. and H. Zhu, (2004) "What Drives Housing Price Dynamics: Cross Country Evidence", BIS Quarterly Review, March, 65-78.

Tupenaite, L., L. Kanapeckiene and J. Naimaviciene (2017) "Determinants of Housing Market Fluctuations: Case Study of Lithuania", *Procedia Engineering*,**172**, 1169–1175.

Vogiazas, S. and C. Alexiou (2017) "Determinants of Housing Prices and Bubble Detection: Evidence from Seven Advanced Economies", *Atlantic Economic Journal*, **45**, 119-131.

Xu, L. and B. Tang (2014) "On the Determinants of UK House Prices", *International Journal of Economics and Research*, **5**, 57-64.

Zhang, Y., X. Hua and L. Zhao (2012) "Exploring Determinants of Housing Prices: A Case Study of Chinese Experience in 1999–2010", *Economic Modelling*, **29**, 2349-2361.

Zhu, H. (2006) "The structure of housing finance markets and house prices in Asia", BIS Quarterly Review, December 2006, 55-69

King, R. (2017) "The Crisis in Affordable Housing is a Problem for Cities Everywhere", October 02, World Resources Institute, Web address: https://www.wri.org/blog/2017/10/crisis-affordable-housing-problem-cities-everywhere (retrieved on 11th November, 2019)