

## Macroeconomic Determinants of House Prices in Malaysia (Penentu Makroekonomi ke atas Harga Rumah di Malaysia)

Saizal Pinjaman  
Mori Kogid  
Universiti Malaysia Sabah

### ABSTRACT

House prices in Malaysia are considered to be seriously unaffordable as the median all-house price is relatively higher than the annual median income. Although the issue of house prices is prevalent in the country, few studies have been done to determine factors that influence its movement. The current paper, therefore, attempts to investigate the causal relationship between macroeconomic variables and house prices in Malaysia by accounting for the existence of a structural break for the variables. It is identified that in the long run, macroeconomic variables are collectively significant in influencing house price movement while the individual impact of macroeconomic variables is varied. The rise in the level of interest rates, housing supply, and inflation will result in the decline in house prices while gross domestic product and local currency appreciation cause the price to increase. It was found that stock prices do not significantly influence house prices. Of all the macroeconomic factors analyzed, exchange rate fluctuations appear to be most significant in explaining the movement of house prices. In the short-run, all macroeconomic factors are individually significant in influencing house prices and it is also identified that house prices tend to move back into their long-run state after temporary macroeconomic shocks with the speed of adjustment around 5.2 percent quarterly. It is advised for the policymakers to constantly monitor the movement of macroeconomic factors and take necessary actions to cushion the adverse impact of the movement of house prices in the country.

*Keywords:* house price; macroeconomic variable; causal relationship

### ABSTRAK

Harga rumah di Malaysia dianggap sangat tidak mampu dimiliki yang mana harga median semua jenis rumah secara relatifnya adalah lebih tinggi berbanding dengan median pendapatan tahunan. Walaupun isu harga rumah adalah lazim dalam negara, terdapat sedikit kajian yang dilakukan bagi menentukan faktor-faktor yang mempengaruhi pergerakannya. Maka, kertas ini mengkaji perhubungan bersebab di antara pemboleh ubah makroekonomi dan harga rumah di Malaysia dengan mengambil kira kewujudan 'structural break' bagi pemboleh ubah. Didapati bahawa dalam jangka masa panjang, pemboleh ubah makroekonomi secara kolektif adalah signifikan dalam menerangkan pergerakan harga rumah, manakala kesan makroekonomi secara individu adalah berbeza. Kenaikan kadar bunga, penawaran rumah dan inflasi membawa kepada penurunan harga rumah, manakala pertumbuhan ekonomi dan peningkatan nilai mata wang tempatan akan meningkatkan harganya. Harga saham pula adalah tidak signifikan dalam mempengaruhi harga rumah. Dalam semua pemboleh ubah yang dianalisis, turun naik kadar pertukaran dilihat lebih penting dalam menerangkan pergerakan harga rumah. Dalam jangka masa pendek, semua faktor makroekonomi adalah signifikan secara individu dalam mempengaruhi harga rumah dan turut dikenal pasti adalah harga rumah yang mempunyai kecenderungan untuk bergerak semula ke dalam hubungan jangka panjang selepas kejutan sementara makroekonomi dengan kelajuan pelarasan sekitar 5.2 peratus dalam tempoh suku tahunan. Kajian ini menyarankan agar penggubal dasar perlulah sentiasa memantau pergerakan faktor makroekonomi dan mengambil tindakan yang sewajarnya dalam mengurangkan kesan negatif pergerakan tersebut terhadap harga rumah dalam negara.

*Kata kunci:* harga rumah; pemboleh ubah makroekonomi; perhubungan bersebab

### INTRODUCTION

The house is an essential asset that individuals require for shelter and social activities. Based on the Maslow Hierarchy of Needs, house ownership is related to all five-tier needs, from the basic physiological to the most advanced self-actualization needs. For those who are economically capable to purchase multiple houses, it

is also an attractive asset for economic reasons where it can be used to generate wealth through rental and property sales.

Bank Negara Malaysia (2012) has acknowledged the importance of the housing industry on the Malaysian economy as can be seen by its dominance in the financial market. Bank lending that includes debt securities held by banks is arguably mostly concentrated on real estate,

particularly the residential segment, then on other market areas of the economy. Bank Negara Malaysia (2012) reported that the banking system aggregate financing for property development and procurement reached RM454.3 billion or 41 percent of total financing at the end of 2012. From this amount, the exposure of banks to the residential property market in the form of financing for property purchases amounted to RM303.9 billion or 27.4 percent of total loans in the banking system, while RM19 billion were loans on working capital and construction property connecting loans. With the substantial size of the housing market with respect to the financial sector, any discouraging movements or issues in the housing market will, directly and indirectly, expose the country to certain degrees of economic risk.

One of the currently highly debated topics in Malaysia is the issue that house prices are said to be too high in comparison to income growth. As shown in Figure 1, the house price in Malaysia in general increased by 149 percent in 16 years from RM135,293 per unit in the first quarter of 2000 to RM337,096 in the last quarter of 2016. However, the income of Malaysians that is reflected by the gross domestic product per capita is comparatively more volatile throughout the years and in a downward trend starting from 2010. It is demonstrated that the rate of increase in gross domestic per capita for Malaysia in the same period increased by just 135 percent from RM16,949 to RM39,840, 14 percent lower than the rate of increase in house prices<sup>1</sup>.

This situation leads to the issue of housing affordability among Malaysians. Based on the report made by Ismail et al. (2019) for the Khazanah Research Institute, the Malaysian residential market has surpassed the affordability threshold of 3.0 times median annual household income and has constantly exceeded 4.0 times from 2002 to 2016. From Table 1, four markets are considered severely unaffordable, namely Kelantan, Sabah, Pulau Pinang, and Negeri Sembilan. In these markets, the median house price is five times higher than the yearly median income. Bank Negara Malaysia (2017) said that houses in Malaysia are still considered unaffordable in 2016 based on the international standard of Median Multiple 5.0. The maximum median price of a house considered affordable in Malaysia is estimated to be RM282,000 and lower than the real median house price of RM313,000. Comparatively, the average median monthly income of Malaysians is only RM5,288.

Besides the issue of affordability, high house prices also lead to other serious economic and social problems. Bank Negara Malaysia (2012) reported that developments in the housing market can have a significant influence on monetary or financial stability. Variations in house prices are believed to demonstrate a direct and indirect influence against the demand for loans by households and their capability to pay off debts. This is more severe in the case of escalating house prices that are not accompanied by rigorous lending standards

and may lead to excessive accumulation of debt by households and housing developers.

Based on a report made by Carter (2013), high house prices dampen economic growth, placing growing pressure on current infrastructure, escalating business costs, aggravating skill deficiencies, and preventing individuals from relocating to a successful city. Case et al. (2013) and Mian et al. (2014), meanwhile believe that house price-induced changes in wealth cause substantial movements in household expenditure and were a significant force in the recent recession. Stroebel (2015) argues that high house prices can lead to an increase in the prices of retail goods. This happens due to the wealth effect. As homeowners feel wealthier due to the increase in house prices, they will then pay less attention to the prices of retail goods. Retailers then respond by increasing their price mark-ups.

On social aspects of the matter, the high cost of acquiring or renting a house pushes city dwellers to live in informal settlements such as squatters and put themselves vulnerable to health and social problems due to the lack of facilities such as electricity, sanitary, and clean water in these areas. A high crime rate that is related to squatters may put city dwellers who are not able to stay in a properly developed area in danger. This is reflected by Mat Zin (2001) who reported that cases such as stealing, burglary, car theft, and drugs frequently occurred in squatters around Kuala Lumpur. Meth (2017) meanwhile contextualized the concern on housing structures in informal settlements in relation to high crime and violence rates. Meth (2017) argues that the incidents of crime can be indicated to the relatively high permeability of informal residential areas.

Analyzing factors that cause house prices to increase, it is demonstrated by many researchers abroad that macroeconomic factors play a big part in determining their movement. Sutton (2002) for example pointed that house price volatility can be linked to the movement in stock prices, interest rates, and income. A more recent study by Glindro et al. (2011) meanwhile argues that higher income, an increase in the real effective exchange rate, institutional factors, and broad credit availability are also associated with the increase in house prices.

In the case of Malaysia however, few attempts were performed to explore this relationship even though the issue of high house prices is prevalent in the country. Among the very few researches conducted in Malaysia was Lean and Smyth (2014), Trofimov et al. (2018), Sukrri et al. (2019a), and Sukrri et al. (2019b). Yet many other macroeconomic factors that could potentially influence house prices were left unchecked and need to be analyzed to deepen the understanding of this prolonged issue. Using findings from abroad to understand the relationship in the local context may be less ideal due to the heterogeneity of house price factors. Glindro et al. (2011) for example believe that

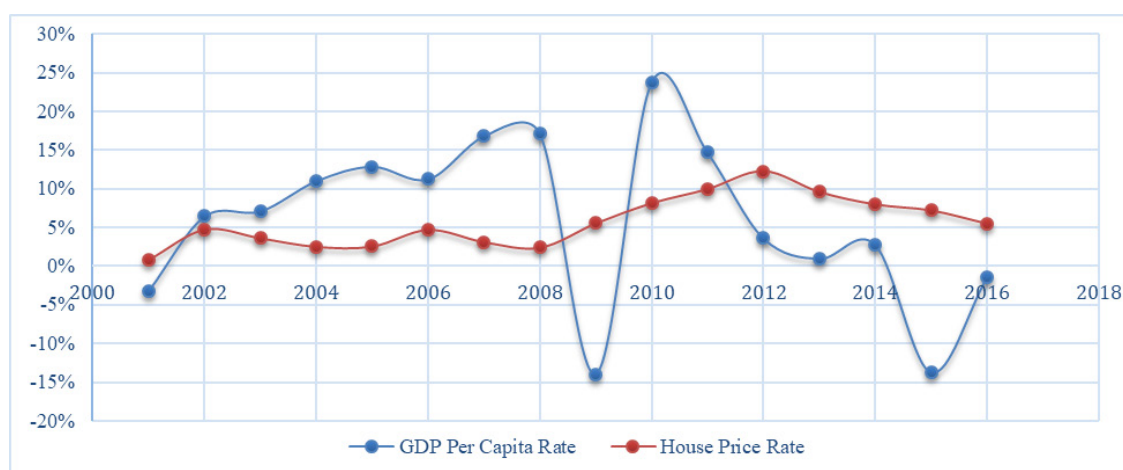


FIGURE 1. Comparison between gross domestic per capita growth and house price change rate *Source:* National property information centre of Malaysia (2016) and the world bank open data (2018)

TABLE 1. Median multiple affordability by states in Malaysia, 2002 - 2016

State/Area	2002	2004	2007	2009	2012	2014	2016	Affordability Classification
Kelantan	5.1	5.4	4.4	4.5	6.2	7.1	5.5	Severely unaffordable 5.1 and over
Sabah	6.3	6.7	10.0	6.2	5.8	5.6	5.5	
Pulau Pinang	4.1	4.3	4.1	4.0	4.1	5.8	5.5	
Negeri Sembilan	3.4	3.1	3.3	3.4	2.8	5.0	5.1	Seriously unaffordable 4.1 to 5.0
Pahang	5.0	4.2	3.7	3.9	3.8	5.3	5.0	
Johor	4.9	4.9	3.5	3.7	3.7	4.3	5.0	
Malaysia	4.1	4.3	4.4	4.4	4.0	5.1	5.0	Moderately unaffordable 3.1 to 4.0
Terengganu	4.7	4.8	5.0	5.2	5.3	6.2	5.0	
Kuala Lumpur	4.7	5.4	5.0	4.6	4.9	5.6	4.9	
Selangor	3.7	3.5	3.6	3.6	3.6	5.2	4.7	N/A
Perak	3.9	4.1	3.5	3.5	3.3	5.1	4.6	
Kedah	4.6	4.1	4.1	4.0	3.6	3.4	4.3	
Sarawak	N.A.	N.A.	3.7	4.1	4.0	4.2	4.0	Moderately unaffordable 3.1 to 4.0
Perlis	4.4	3.7	3.6	4.5	4.3	4.5	4.0	
Melaka	3.4	3.5	2.9	2.9	2.6	3.1	3.1	

*Source:* Ismail et al. (2019).

*Note:* 1. Median multiple affordability is determined based on the ratio of the median all-house price by the household median income.  
2. N.A. refers to the non-availability of the data.

the leading determinants of house prices are market-specific and it is important for these differences to be taken into account in the analysis.

The research documented in this paper has two objectives with the first being to identify the impact of selected macroeconomic factors on house prices in Malaysia for both long-run and short-run. Additionally, this paper attempts to identify the time it takes for house prices to move back into their long-run state due to temporary macroeconomic movements. These attempts were set by considering the shortcomings of

previous literature in analyzing the topic in Malaysia. It is imperative to extend the knowledge obtained from previous analyses and broaden the understanding of this issue so that necessary actions or plans can be drawn to address the problem of house prices in the country. Moreover, this study can also be used as a reference or extended for future analyses.

The remainder of this paper is organized as follows: Section 2 discusses previous literature on house price determinants. Section 3 meanwhile describes the data as well as causal relationship assessment methods. Section

4 shows the estimation results, and the paper ends with conclusions in Section 5.

## LITERATURE REVIEW

### UNDERLYING THEORIES

According to Nakajima (2011), it is possible to have three groups of theories that attempt to explain the movement of house prices. The first group of literature focuses on the inflexible nature of housing supply that is associated with a longer period to build houses and the scarcity of land, particularly in urban areas. Based on the study conducted by Glaesar et al. (2002) who investigated the supply-side restrictions, it is identified that tightened housing supply regulations contribute to the increase of house prices. This is similar to the findings of Hilber and Vermeulen (2013) who discovered that the English planning system is an important determining factor towards the issue of housing affordability, particularly in urban areas. Another factor that can be linked to the housing supply side is the role of a limited supply of land and this is agreed by Ho and Ganesan (1998). Based on their findings, Ho and Ganesan (1998) identified that an increase in land supply will bring forth a decrease in housing prices.

The second group of theories mentioned by Nakajima (2011) investigates the demand side of the housing with factors such as demographics and income or wealth being identified as dominant factors. Adding to the theory, Ho and Ganesan (1998) noted that house prices in Hong Kong are mainly influenced by demographic factors particularly its growing population and income. Nakajima (2011) believes that house prices increase when income is more volatile since the household is encouraged to save their total wealth. Meanwhile, Glindro et al. (2011) elaborated that there are two ways on how demand can be affected, namely based on the substitution and wealth effects. The substitution effect causes the price of two substituting assets to move in opposing directions and eventually causes the price of the assets to exhibit negative relationships. Conversely, the wealth effect leads to an increase in the demand for an asset as the wealth of an individual grows.

The other strand of literature investigates the role of expectation on house price dynamics. Based on this theory, house prices are determined by the changes in the expectation of their future prices. It is believed that the expectation theory is rather important since house prices are more volatile than the movement of fundamental factors. Based on the theory of Irrational Exuberance explained by Schiller (2016), it is the extreme enthusiasm of the investors that drives house prices further upward and expects further increases in price and returns. Eventually, when the house price exceeds the changes in fundamental factors, a price

bubble takes place. The increase in expectation is associated with several fundamental variables including sustained income growth (Kahn 2008) and house price momentum (Piazzesi & Schneider, 2009).

### EMPIRICAL STUDIES IN INTERNATIONAL MARKETS

Sutton (2002) examined the degree to which house price variations can be attributed to fluctuations in incomes, stock prices and interest rates. Focusing on six advanced economies, namely the United States, the United Kingdom, Canada, Ireland, the Netherlands, and Australia, Sutton (2002) collected the quarterly data from the 1970s to 2002 and employed the small-scale vector autoregressive (VAR) model. It was identified that the factors studied were significant in explaining changes in house prices. It was also demonstrated that the growth of national income leads to an increase in house prices for each country. Meanwhile, shocks to real interest rates exhibit a negative relationship with house prices where a fall in real long- and short-term interest rates leads to an increase in house prices. The estimated model also implies the presence of a positive relationship between changes in equity and house prices for all countries. In addition to detecting the reaction of house prices to a specific shock, Sutton (2002) also employed the VAR to examine the relative importance of different disturbances in explaining the movement of house prices. According to Sutton (2002), the relative significance of different disruptions differs across countries. For most, changes in stock prices seem to be more significant in explaining larger variances of house price growth.

Unlike Sutton (2002) that investigated the housing price factors in various developed countries, Capozza et al. (2002) focused solely on the single-family housing market in the U.S. The analysis made can be considered extensive from another perspective as it employs both a time series and a large panel data set that includes demographic, economic and political determinants in 62 US metropolitan areas based on the data from 1979 to 1995. Based on the Ordinary Least Square (OLS) and panel data estimator to gauge the long-run relationship, Capozza et al. (2002) argued that house prices are positively related to the total population, population growth, construction cost and real median income where the increase in these macroeconomic and demographic variables will lead to a similar movement towards house prices. In line with the supply-side theory of house prices, the cost of housing and the land supply index are demonstrated to exhibit an inverse relationship with the prices.

Using quarterly data from 1970 to 2003, Tsatsaronis and Zhu (2004) analyzed house price determinants for 17 industrialized economies and focused both on the supply side and demand side of the house price theories. One of the key features of the

study by Tsattsaronis and Zhu (2004) that sets it apart from Sutton (2002) and Capozza et al. (2002) is that it identifies the dominant impact of inflation and short-term interest rates. However, Tsattsaronis and Zhu (2004) share a similar method with Sutton (2002) by employing the VAR model in analyzing the relationships and identified that inflation is an important determinant of housing prices where around 50 percent of the total variation in house prices are accounted by inflation for most of the countries analyzed. On the other hand, the short-term interest rate is identified to be the second most important determinant as it explains 10 percent of the movement in house prices. Sutton (2002) reported that two other variables related to mortgage finance that are significant in explaining house prices are bank credit and term spreads. Meanwhile, household income is identified to have a small effect on house price movements.

Geng (2018) analyzed the impact of macroeconomic factors towards housing prices for 12 advanced OECD economies based on panel cointegration tests and explained that the fundamental causes of house prices can be separated into three factors: demand, supply, and structural or institutional factors. This is an addition to the strands of literature explained by Nakajima (2011) that included the influence of expectation as the third theory of housing price determinants. For the demand factors, Geng (2018) corroborated the findings of Sutton (2002) and Tsattsaronis and Zhu (2004) where it is believed that variables such as household disposable income, net financial wealth, demographic trends, and interest rates are important. Similar to Capozza et al. (2002), it was also identified that supply lags that react to demographic needs lead to sustained increases in the ratio of population to the stock of dwellings in the long-run. This response is said to lead to housing prices rising faster than income. On the other hand, Geng (2018) argued that structural or institutional factors affect house prices through tax incentives for mortgage financing as well as rent controls. Geng (2018) adds that the effect of demand and supply factors on long term house prices differs across countries depending on the policy and structural aspects<sup>2</sup>.

Apart from Geng (2018), another research that focuses on OECD countries is by Sabyasachi (2019). Based on data from 1970 to 2017, Sabyasachi (2019) employed the Random Effects model to investigate the impact of macroeconomic factors on house prices and it was demonstrated that determinants such as gross domestic product, price-to-income ratio, money supply, inflation, exchange rate, and urbanization exhibit a positive relationship with house prices. Sabyasachi (2019) extended the analysis on demographic factors and coincided with the literature on the supply side of house price theory such as Ho and Ganesan (1998) and Capozza et al. (2011) where the population was proven to be a significant variable. Sabyasachi (2019)

added that an increase in the services sector's share of employment will cause house prices to fall.

#### EMPIRICAL STUDIES IN MALAYSIA

Glindro et al. (2011) examined house price movements in nine economies in the Asia Pacific region that included Australia, China, Hong Kong, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand by attempting to determine the influence of macroeconomic and institutional factors on house price movements as well as gauging whether there is a housing bubble. They used quarterly data from 1993 to 2006 for the residential property sector in 32 cities across the nine countries selected. Utilizing the panel data regression analysis, their findings are in line with Sutton (2002), Capozza et al. (2002), and Geng (2018) by arguing that higher income, index of land supply, institutional factors, and greater credit availability influence the development of house prices. It was also identified that the depreciation of real effective exchange rates and increasing real mortgage rates and equity prices dampen house prices. Glindro et al. (2011) also identified that the evidence of a housing price bubble or overvaluation is weak at the national level. However, speculative housing bubbles may be present in certain or specific market segments.

Based on quarterly data from 2001 to 2012, Bank Negara Malaysia (2012) employed a similar method to Capozza et al. (2002) by employing the OLS method to find the significance of variables in macroeconomic, financial, and government policies towards house prices and identify the dominant variables. Real gross domestic product, consumer sentiment, population, and inflation were found to be positively related to housing prices while the increase in property gains tax and base lending rates lowers the price level. On the other hand, the inverse relationship between the construction material cost and house prices contradicts the findings of Capozza et al. (2002). From the year 2010 to 2012, it was also observed that the loan to value ratio and lagging of house prices were also significant in influencing current house prices. Adding to the third strand of literature mentioned by Geng (2018), Bank Negara Malaysia (2012) acknowledged the impact of government policies towards house prices even though their influence is shown to be minimal.

Lean and Smyth (2014) meanwhile analyzed to find out the dynamic relationship between house prices, interest rates, and stock prices in Malaysia. Utilizing the ARDL bounds test for cointegration, it was identified that a long-run relationship did not exist between house prices, interest rates, and stock prices for Malaysia as a whole. However, there are numerous indications of interest rates and stock prices influencing house prices in more urban states such as Selangor, Kuala Lumpur, and Penang. Lean and Smyth (2014) argued that the rising foreign ownership of shares, combined with

rapid growth in property ownership by foreigners may explain the deficiency of cointegration for Malaysia as a whole. Strengthening the findings of Sutton (2002), the coefficient for stock prices is identified to be positive and significant, while the interest rates' coefficient is negative and insignificant. Although the speed of adjustment of house prices to equilibrium differs between regions, Lean and Smyth (2014) believe that house prices adjust fairly quickly towards long-run relationships if there are any shocks in the stock prices and interest rates. In the short-run, there are no clear patterns in the relationship between interest rates and stock prices with the movement of house prices for several housing markets. This suggests the segmentation of the housing market in Malaysia.

Trofimov et al. (2018) used quarterly data from 2001 to 2015 to explain the contributing factor of demographics and macroeconomic variables on Malaysian property prices by focusing on the demand side of the house price theory. Based on the Vector Error Correction Model (VECM) employed, it was identified that the population had a significant and positive relationship with the demand for residential properties. The increase in residential property demand causes house prices to move upward. Similar to Bank Negara Malaysia (2012), Trofimov et al. (2018) included the gross domestic product and base lending rate in the analysis and both variables were identified to be negatively related to the prices of residential properties where an increase in the gross domestic product and base lending rate dampens house prices. In line with Tsatsaronis and Zhu (2004), a positive and significant relationship was also identified between the consumer price index and residential property prices in the country.

Further developing the enhanced house price index model for Malaysia, Sukrri et al. (2019a) followed a Laspeyres Approach where the index is modeled by integrating the demand and supply determinants of house prices. According to Sukrri et al. (2019a), a Laspeyres Approach is an index formula used to gauge the price growth of a basket of goods and services consumed over a base period. The advantage of this approach is that the index can be extended to include additional prices observed. Similar to Lean and Smyth (2014), the ARDL model is then employed to assess the dynamics between house prices and their determinants. In the long-run, it is identified that the overnight policy rate, employment, and consumer price are positively related to housing prices while housing loans dampens its movement. Contradicting Capozza et al. (2002) and Bank Negara Malaysia (2012), the increase in land supply was identified to cause house prices to move upward while construction costs were found to be insignificant.

Utilizing quarterly data from the period 2008 until 2017, Sukrri et al. (2019b) extended the analysis made by Sukrri et al. (2019a) by investigating the impact of macroeconomic factors on house price index in Malaysia

for both long-run and short-run. Similar to Sukrri et al. (2019a), the analysis also utilizes the Laspeyres Approach to obtain a type of enhanced house price index that incorporates demand and supply determinants. In order to identify the long-run relationship between the variables, Sukrri et al. (2019b) employed the ARDL model and identified that macroeconomic factors are jointly significant in explaining the movement of the enhanced house price index. Based on the individual macroeconomic analysis, construction cost and housing loans are identified to be significant in influencing house prices with positive relationship, while overnight policy rate and land supply are not. The Error Correction Model (ECM) is then employed to identify the short-run impact and Sukrri et al. (2019b) demonstrate that about 40 percent of the disequilibrium in the relationship that happens due to the macroeconomic shocks is corrected within one period.

As briefly discussed in the Introduction, there are limited researches that have been performed for Malaysia to analyze the relationships between macroeconomic factors and house prices. Even though there are studies conducted such as Trofimov et al. (2018), Sukrri et al. (2019a), and Sukrri et al. (2019b), these researches did not incorporate the existence of structural breaks in analyzing the impact of macroeconomic factors. According to Perron (1989), ignoring the existence of structural breaks may weaken the power of rejecting a false null hypothesis. On the other hand, research such as Lean and Smyth (2014) who considered the structural breaks focused only on the demand side of house price theory by exploring the dynamic interaction between house prices, interest rates, and stock prices. Meanwhile, other macroeconomic variables including the supply side of house price factors that may be important were excluded. Thus, the current paper tries to fill in the gap by investigating the impact of macroeconomic variables on both the demand and supply sides while incorporating the existence of structural breaks in the unit root and cointegration analysis. To extend the contribution on the supply side of house price theory, the current paper explores the impact of housing supply rather than looking into the influence of land availability as investigated by Ho and Ganesan (1998) and Capozza et al. (2002).

## DATA AND METHODOLOGY

The analysis covers 17 years of housing prices and macroeconomic quarterly data from 2000 until 2016. There are six macroeconomic factors selected based on previous studies: i) base lending rate, ii) real gross domestic product, iii) housing stock (to represent the level of housing supply), iv) consumer price index (to represent inflation), v) real effective exchange rate, and vi) stock prices. The housing price and macroeconomic

variables are transformed into natural logarithms. The long-run and short-run relationship between macroeconomic factors and house prices in Malaysia are analyzed using cointegration and error correction modeling<sup>3</sup>.

#### UNIT ROOT TEST WITH STRUCTURAL BREAK

The first step in analyzing the relationship between macroeconomic determinants and house prices is by conducting the unit root test. However, Perron (1989) reported that the existence of structural breaks on data that is trend stationary causes conventional unit root tests to become biased towards a false null hypothesis of a unit root. In relation to that, the current paper employed a unit root test that allows for a one-time break where the breaking point date is selected based on the minimum Dickey-Fuller t-statistics. This model also follows an assumption that the data is non-trending while the break occurs gradually. The number of lags is selected based on the Schwarz info criterion.

#### AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) MODEL FOR LONG-RUN RELATIONSHIP

The cointegration test that is used in this research is based on the Autoregressive Distributed Lag Model (ARDL). Besides its ability to analyze the model with structural breaks and causal relation for variables in different orders of integration (Pesaran and Pesaran, 1997), the ARDL model also solves the problem of autocorrelated errors that is suffered by the finite distributed lag model (Hill et al., 2008). Pesaran and Shin (1997) added that the ARDL estimate for long-run coefficients are also consistent whether the regressors are all I(0) or I(1).

The estimation of the long-run relationship between variables by using the basic ARDL (p,q) model is shown below;

$$y_t = \alpha + \sum_{i=1}^p \theta_i y_{t-i} + \sum_{i=0}^q \beta_i x'_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x'_{t-1} + \varepsilon_t \quad (1)$$

Where  $\varepsilon_t$  is the error term and  $\alpha$ ,  $\theta$ ,  $\beta$  and  $\lambda$  are the coefficients that need to be estimated. In the current paper,  $y$  is referred to as the house price while  $x'$  is a set of macroeconomic variables selected, namely the interest rate, real gross domestic product, housing stock, inflation, exchange rate and stock price.

Optimal lags in the ARDL model for this analysis are determined by the Akaike Info Criterion (AIC) where a model with a certain number of lags in the right-hand side of the variable that produces the lowest value of AIC is considered optimal. The current paper sets the maximum number of lags into four, which is equivalent to one year<sup>4</sup>.

To test for the significance of breaking point in explaining the level of housing price, a dummy

variable that accounts for the breakpoint periods of macroeconomic factors and housing price as well as the intercept are treated as fixed regressors.

To identify the existence of a long-run relationship, bounds test of Pesaran, Shin and Smith (2001) is conducted to test the following hypotheses:

1.  $H_0: \lambda_1 = \lambda_2 = 0$ , indicating the non-existence of a long-run relationship among variables.
2.  $H_1: \lambda_1 \neq \lambda_2 \neq 0$ , indicating the existence of a long-run relationship among variables.

The hypotheses are assessed or tested by comparing the estimated F-statistics of bounds test with two critical bounds values for a given significance level, namely lower bound and upper bounds critical values, obtained from Pesaran et al. (2001). The null hypothesis is rejected when the value of F-statistics is higher than the upper critical bound and the rejection of the null hypothesis indicates there is a long-run relationship between the housing price and macroeconomic factors. On the other hand, if the F-statistics is smaller than the lower critical bound, then the null hypothesis is failed to be rejected and indicates no significant long-run relationship between the variables. However, when F-statistics is between the upper and lower critical bound, then the relationship between the variables is inconclusive or undetermined in the long-run.

#### SHORT-RUN RELATIONSHIP AND SPEED OF ADJUSTMENT

The short-run relationship is obtained from an Error Correction Model (ECM) as shown in Equation (2) with Error Correction Terms (ECT) representing the speed of adjustment for the model to reach equilibrium or long-run relationship. Based on Engle and Granger (1987), the error correction model shows the reaction of the dependent variable to shocks of the regressors or independent variables and it also indicates the proportion or fraction of the disequilibrium from one period that is corrected in the next period.

$$\Delta y_t = \alpha + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \sum_{i=0}^q \beta_i \Delta x'_{t-i} + \lambda_1 ECT_{t-1} + \varepsilon_t \quad (2)$$

Where  $ECT_{t-1} = \varepsilon_{t-1} = y_{t-1} - \alpha - \beta x'_{t-1}$ .

A least square estimation is carried out to analyze the ECM model and the number of lags in the model is determined based on the lowest Akaike Info Criterion values. If  $\beta \neq 0$  then it shows that  $x'$  is significant in influencing  $y$  in the short-run. This implies that there exists a short-run relationship between the housing price and macroeconomic determinants.

Meanwhile for the ECT terms,  $-1 < \lambda < 0$  indicates a significant adjustment of the model towards equilibrium in the long-run. Since ECT indicates the proportion or percentage of the disequilibrium from one period that is

corrected in the next period as mentioned by Engle and Granger (1987), then the period for the disequilibrium to be completely corrected is equal to 1 divided by the value of the ECT coefficient, or  $(1/\lambda)$ . Since this research is using quarterly data, then  $(1/\lambda)$  shows the total number of a quarter(s) for the model to reach its equilibrium or long-run relationship.

#### DIAGNOSTIC AND STABILITY TESTS

The existence of a serial correlation in the ARDL and the ECM models will be tested by using the Breusch-Godfrey serial correlation LM test meanwhile the stability of the models is examined by using the CUSUM test. Ramsey (1969) Regression Specification Error Test (RESET) on the other hand is utilized to identify whether the models are correctly specified or otherwise. To test the presence of heteroskedasticity, this paper conducted the Breusch-Pagan test with the null hypothesis that suggests the non-existence of heteroskedasticity.

#### RESULT ANALYSIS

This research employs a unit root test that allows a one-time structural break where the number of lags is determined according to the Schwarz criterion. Based on the results as shown in Table 2, it is identified that the level of stationarity is mixed with the interest rate, real gross domestic product, housing supply, inflation, stock price and the exchange rate is stationary at the first difference or  $I(1)$  while the house price is stationary at level,  $I(0)$ . The mixture of stationary levels of the variables justifies the use of the ARDL model to analyze the relationship between housing prices and macroeconomic factors in the long-run.

In determining the period of the structural break for each variable, minimum Dickey-Fuller t-statistics is used and it appears that the breakpoint period for the

interest rate and house price occurs at a similar period, that is 2008 Q3. The breakpoint period for the real gross domestic product occurred in 2011 Q1 while a similar phenomenon is experienced by housing supply in a more recent period. The earliest breaking point is shown by the level of inflation where it appears in the last quarter of 2004. Stock prices exhibit breakpoint in the first quarter of 2013 while the breakpoint period for the exchange rate is shown in 2009 Q4. The existence of a structural break in the unit roots shows the significance of incorporating the element in exploring the impact of the macroeconomic determinants on house prices.

The optimal ARDL lags in the analysis are (4, 3, 4, 3, 3, 4, 4) as the model produces the lowest value of AIC. As demonstrated in Figure 2, the house price, real gross domestic product, exchange rate, and stock price are set to 4 lags while the interest rate, house stock, and inflation contain 3 lags.

Table 3 shows the bounds test based on the ARDL model that is applied to analyze the joint significance of the regressors in explaining the housing price in Malaysia in the long-run. It is identified that the F-statistics is higher than the upper critical bound at any significance level and suggests the rejection of the null hypothesis of no cointegration between variables in the model. This implies that the macroeconomic variables are jointly significant in influencing house prices in the country. By referring to the diagnostic tests, it is evident that the model did not exhibit the problem of serial correlation and is also free from heteroskedasticity as shown by the Breusch-Pagan-Godfrey test. The Ramsey RESET test on the other hand suggests that the cointegration model is correctly specified.

By referring to the long-run coefficient of the independent variables in Table 4, the majority of macroeconomic factors are significant in determining the level of housing price. The interest rate is identified to demonstrate a negative relationship with the housing price and significant at a 10 percent level where an

TABLE 2. Unit root test with breakpoint

Variable	Breakpoint Period	ADF Test Statistics	
		At level	At 1 <sup>st</sup> difference
House price	2008 Q3	-5.7851***	-9.4780***
Interest rate	2008 Q3	-3.8703	-10.1512***
Real gross domestic product	2011 Q1	-4.4585	-8.9448***
Housing supply	2015 Q4	-4.3809	-10.9010***
Inflation	2004 Q3	-4.0847	-8.2179***
Stock price	2013 Q1	-4.3932	-6.4839***
Exchange rate	2009 Q4	-3.1154	-8.4020***

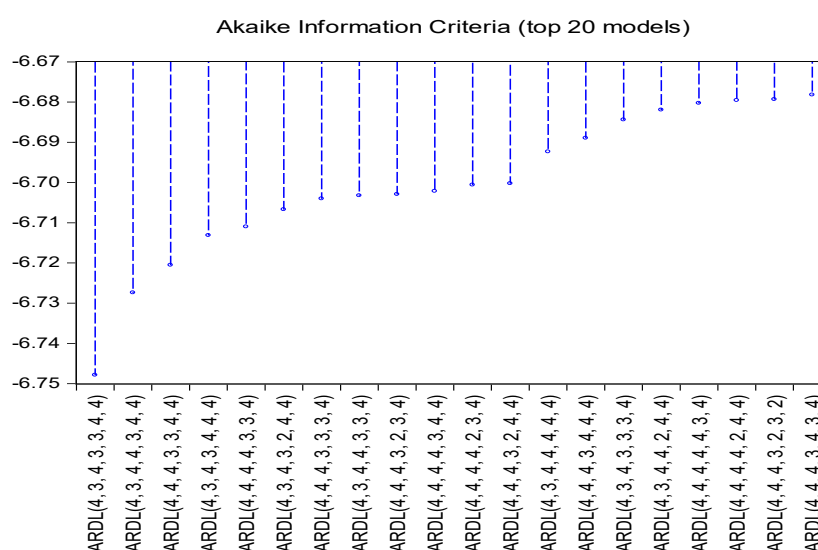
- Note:
1. The model assumes that the break occurs gradually and follows the same dynamic path as the innovations.
  2. The data is also assumed trending with breaks in the intercept and trend.
  3. The number of lags is selected based on Schwarz information criterion while the breaking point date is selected based on the minimum Dickey-Fuller t-statistics.
  4. Null Hypothesis: The model tested contains a unit root.



TABLE 3. Long-run relationship between housing price and macroeconomic movement

ARDL Model: (4,3,4,3,3,4,4)		
F-Statistic: 6.8202		
Critical Value	Lower Critical Bound	Upper Critical Bound
10% Significance	2.12	3.23
5% Significance	2.45	3.61
1% Significance	3.15	4.43
Breusch-Pagan Serial Correlation LM Test	F-statistic	0.8284
	Prob. Chi-Square(2)	0.1488
Breusch-Pagan-Godfrey Heteroskedasticity	F-statistic	0.8178
	Prob. Chi-Square(32)	0.5888
Ramsey RESET Test	F-statistic	1.8567
	Probability	0.1852

Note: 1. The long-run relationship between Housing Price and macroeconomic factors is analyzed based on the Bounds test of cointegration with hypothesis null assuming no correlation between variables.  
 2. The model includes a constant term while the breaking point is treated as a fixed regressor.



Note: The number of lags for the independent variables in the model is selected based on the lowest Akaike info criterion value with the maximum number of lags is set to four.

FIGURE 2. ARDL lag selection criteria

increase in the level of interest rates by 1 percent will cause the housing price to fall by 1.7 percent. The reason for an increase in the interest rates to cause house prices to fall can be seen from the demand side of house price theories where the interest rate increases the cost of financing and adversely impacts the level of demand for houses. With fewer housing demand in the economy, house prices will tend to fall.

Validating the income effect of the demand side of house price theory, a positive relationship is exhibited between real gross domestic product and housing price. Based on the coefficient value, 1 percent growth in the variable will cause an increase in housing prices by 2.4 percent at 1 percent significance level. The positive relationship between real gross domestic product and

house prices happens because an increase in economic growth causes incomes to rise. Following the movement of income, housing demand will increase and push house prices upward.

The level of housing supply and price on the other hand exhibits a significant negative relationship at 5 percent level. A fall in the housing supply by 1 percent leads to an increase in prices. The impact of housing supply on house prices can be explained through the supply side of house price theory where an increase in house supply causes house prices to fall.

Due to the wealth effect, an increase in the level of inflation causes the household's purchasing power to fall and leads to decreasing demand for houses. This adverse impact of inflation on housing demand causes

TABLE 4. Long-run coefficient

Independent Variable	Coefficient
Interest rate	-1.7452*
Real gross domestic product	2.4393***
Housing stock	-2.4563**
Inflation	-0.2482*
Exchange rate	4.8746*
Stock price	-0.4208
Structural break	0.0591
Constant	22.2122

Note: 1. Long-run coefficients of macroeconomic factors with respect to Housing Price is analyzed based on the ARDL (4,3,4,3,3,4,4) model.  
2. Standard errors are shown in parentheses with \*, \*\*, \*\*\* indicate statistical significance at 10%, 5% and 1% level, respectively.

house prices to drop in the long-run. The negative relationship between inflation and house prices shows the seriousness of the housing unaffordability in the country where an increase in inflation incapacitates the ability of individuals to purchase a house. Based on the analysis, it is identified that a 1 percent rise of inflation causes house prices to fall by 0.25 percent and this relationship is significant at 1 percent level.

The exchange rate, represented by the REER, exhibits the largest magnitude of impact on housing prices as shown by high coefficient value. A 1 percent increase in the exchange rate, which indicates that exports become expensive while imports become cheaper, causes the housing price to increase by 4.9 percent and significant at the 10 percent level. This corroborates the wealth effect based on the demand side of house price theory since the appreciation of local currency can be translated to the growth in wealth due to international trade. As wealth or income grows, the housing demand will expand and eventually lead to an increase in house prices. Based on Glindro et al. (2011), an increase in the real effective exchange rate is associated with the increase in house prices due to the prospect of higher capital gains from the exchange rate.

The movement in stock prices exhibits no impact on house prices in the long-run as shown by the coefficient level that is not significant at any level. This situation is believed to happen due to the contradicting impact of the substitution and wealth effects on the demands on an asset. According to Glindro et al. (2011), the substitution effect dictates an inverse relationship between the prices of two assets where the high return in one market causes investors to leave the other market. The wealth effect meanwhile expects a positive relationship since the high returns obtained from one market will increase the investors' total wealth and their capacity of investing in different assets. Although an upsurge in stock prices may cause the demand and price of houses to fall as

explained by the substitution effect, this impact is canceled by the wealth effect and ultimately leaves the price of houses to remain unaffected in the long-run.

Since the unit root tests indicate the presence of structural breaks for the variables, the current paper includes the factor as a fixed regressor in the model. While the structural breaks exhibit positive signs on its coefficient and imply the adverse effect on house prices, the impact is identified to be insignificant in the long-run. This suggests that although macroeconomic variables experience structural breaks due to certain factors, these effects may be momentary or fail to be translated into the movement of house prices.

The result of the Wald test to identify the significance of individual macroeconomic movements towards short-run house prices is shown in Table 5. By referring to the probability value of the F-Statistics, the null hypothesis assumes no causal relation between house prices and macroeconomic factors is rejected at a 5 percent significance level or lower. This indicates that movements in individual macroeconomic determinants are significantly transmitted into the house price in the short-run.

TABLE 5. Short-run relationship between house price and individual macroeconomic movement

Macroeconomic Factor	Wald Test F-statistics (Probability)
Base Lending Rate	4.1895 (0.0131)
Gross Domestic Product	12.4953 (0.0000)
House Stock	17.1222 (0.0000)
CPI	2.5921 (0.0698)
Exchange Rate	6.1198 (0.0009)
Stock Price	4.6804 (0.0044)

Note: 1. The short-run relationship between macroeconomic factors and housing price is analyzed based on the F-statistics obtained from the Wald test with hypothesis null assumes no causal relationship between variables.  
2. Probability value is shown in parenthesis with 0.10(10%), 0.05(5%) and 0.01(1%) significance level.

Based on Table 6, the error correction term is significant at a 1 percent significance level. The negative sign on its coefficient indicates the significant correction of the model into a long-run equilibrium when short-run macroeconomic movements occurred. The value of the coefficient indicates that the 5.3 percent gap between the actual price and equilibrium price is closed within a quarter year. This speed of correction is

rather low and indicates a slow reaction of prices since disequilibrium that occurs due to a short-term deviation in macroeconomic factors is fully corrected only within 19 quarters or 4 years and 3 quarters.

TABLE 6. Short-run adjustment

Variable	Coefficient
Error Correction Term	-0.052607***

*Note:* 1. The coefficient for ECT is identified by inserting the lag value of the ECT as one of the independent variables in the Error Correction Model.  
2. Standard errors are shown in parentheses. \*, \*\*, \*\*\* indicate statistical significance at 10%, 5% and 1% level, respectively.

As can be seen from Table 7, the Breusch-Godfrey LM test indicates that the model is free from serial correlation up to 2 orders while the Breusch-Pagan test conducted suggests that the model did not exhibit heteroskedasticity. Meanwhile, the CUSUM stability test shows that all models are stable against the critical bound of a 5 percent significance level. The Ramsey RESET test, on the other hand, implies that the model is well specified in a linear model since the null hypothesis's correctly specified model is failed to be rejected even at a 10 percent significance level.

TABLE 7. Residual and stability diagnostics

Test	F-Statistics	Probability
Breusch-Godfrey Serial Correlation LM Test	0.969557	Chi-Square: 0.1761
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.805930	Chi-Square: 0.6145
Ramsey RESET Test	0.026494	0.8717
Cusum Stability Test	Stabile at 5%	
Cusum of Squares Test	Stabile at 5%	

*Note:* The number of lags included in the Breusch-Godfrey serial correlation LM test is two (2) while the number of fitted terms in the Ramsey RESET test is one (1).

## CONCLUSION

The current study investigates the relationship between macroeconomic determinants and house prices in Malaysia from 2000 to 2016. Based on the results, the relationship between the variables is consistent with the demand and supply sides of house price theories. In analysing the long-run relationship, the current paper employed the ARDL model and it is found that the joint movement of macroeconomic factors is significant in explaining housing prices in Malaysia. Similar to the findings of Sutton (2002) and Bank Negara Malaysia

(2012), interest rates are identified to have an inverse relationship with house prices where an increase in the said macroeconomic factor causes house prices to fall. Meanwhile as argued by Capozza et al. (2002), Sutton (2002), and Bank Negara Malaysia (2012), a fall in gross domestic product growth is demonstrated to dampen house price growth and validates the income effect. Sharing the same effect as the interest rate, an increase in housing supply and inflation rate causes house prices to fall. The impact of housing supply on lowering the house price extends the findings of previous literatures on the supply side of the house price theory such as Ho and Ganesan (1998) and Capozza et al. (2002). On the other hand, the exchange rate exhibits a positive relationship with house prices as demonstrated by Glindro et al. (2011). According to Glindro et al. (2011), in countries where foreign investment acts as an important contributor to the economy, such as those in Asia, an appreciation of the exchange rate is normally related with housing booms. The relationship between stock prices and house prices meanwhile is identified to be insignificant in the long-run and happens due to the contradicting effect of wealth and substitution effects. Referring to the argument made by Lean and Smyth (2014), a deficiency of cointegration between stock price and house price in the Malaysian market can also occur due to the increasing ownership of shares and property by foreigners. Meanwhile, although the structural break is present on the macroeconomic variables as demonstrated based on the unit root tests, it is shown to be insignificant in explaining the movement of house prices in the long-run.

In analysing the short-run relationship based on the error correction modeling, it is identified that all macroeconomic variables are individually significant in explaining housing price growth. In terms of the speed of adjustment to equilibrium or long-run relationship, short-run shocks in the macroeconomic factors are identified to be corrected within 4 years and 3 quarters. This is in line with the conclusion made by Zaemah (2010) who acknowledged the inefficiency of the housing sector in Malaysia as demonstrated by the slow adjustment process of the housing market towards long-run equilibrium.

By referring to the findings, it is vital for policymakers to constantly monitor the movements of these macroeconomic variables given their significant impact on house prices in the country for both long-run and short-run. Strategies must be constructed to stimulate the growth of housing supply so that it can cushion the impact of the expansion of real gross domestic product and the exchange rate on house prices. Apart from that, monetary policy should also be adjusted to dampen the negative effect of interest rates and inflation since the increased level of these variables weaken the economic ability of the individuals to acquire the asset and leads to a fall in their demand. Since the current paper is

conducted on the aggregate level, it is recommended for future research to consider analysing the relationship based on specific markets and including microeconomic variables. This will expand the understanding of the topic and help to build more precise policies that cater to distinctive characteristics of each specific market in Malaysia.

## NOTES

- <sup>1</sup> Bank Negara Malaysia (2017) reported that from 2007 to 2016, house price rise by 9.8 percent, while household income has increased by just 8.3 percent. This issue is said to be most prevalent between the year 2012 and 2014 where the house price has increased by 26.5% and double the rate of increase in income, which is 12.4%.
- <sup>2</sup> Housing investment tax relief will drive housing demand upwards and lead to the increase of house prices. Positive income shocks lead to a higher price impact in countries with higher tax relief. The long-run supply responsiveness, meanwhile, mainly affects house price elasticities with respect to mortgage rate, with higher long-run impact on real house prices in markets with less elastic supply. Moreover, rent control moderately dampens the effect of supply increases on house prices.
- <sup>3</sup> According to Hill et al. (2008), cointegration analysis is a test to identify the stationarity of the error term where an error term that is stationary indicates the cointegration between the dependent variable and the regressors. When two variables are proved to be cointegrated, it means that their value will not diverge too far from each other and demonstrates a fundamental relationship. Conversely, an error term that is non-stationary implies that the two variables are not cointegrated.
- <sup>4</sup> The Schwarz criterion is not included in the test to avoid the risk of under-fitting the model as the Schwarz criterion tends to select a simpler model specification. This is consistent with Koehler and Murphee (1988), who said that Schwarz criterion leads to a lower model for forecasting.

## REFERENCES

- Bank Negara Malaysia. 2012. *Laporan Kestabilan Kewangan dan Sistem Pembayaran 2012*. Kuala Lumpur: Bank Negara Malaysia
- Bank Negara Malaysia. 2017. *Buletin Suku Tahunan keempat BNM*. Kuala Lumpur: Bank Negara Malaysia.
- Capozza, D.R., Hendershott, P.H., Mack, C. & Mayer, C.J. 2002. *Determinants of real house price dynamics*. National Bureau of Economic Research Working Paper Series No. 9262
- Carter, S. 2013. High house prices damage businesses and the economy. <https://www.theguardian.com/housing-network/2013/jun/20/high-house-prices-damage-businesses-economy> (accessed 2 October 2018)
- Case, K.E., Quigley, J.M. & Shiller, R.J. 2013. *Wealth Effects Revisited: 1975-2012*. National Bureau of Economic Research Working Paper No. 18667
- Engle, R.F. & Granger, C.W.J. 1987. Cointegration and Error Correction Representation, Estimation and Testing. *Econometrica* 55: 251-76
- Geng, N. 2018. *Fundamental Drivers of House Prices in Advanced Economies*. IMF Working Paper No.18/164.
- Glaeser, E. L., Gyourko, J. & Saks, R.E. 2002. Why have housing prices gone up? *American Economic Review* 95(2): 329-333
- Glindro, E.T., Subhanij, T., Szeto, J. & Zhu, H. 2011. Determinants of house prices in nine Asia pacific economies. *International Journal of Central Banking* 7: 163-204
- Hilber, C.A.L. & Vermeulen, W. 2013. *The Impact of Supply Constraints on House Prices in England*. Institut d'Economia de Barcelona Working Paper N. 2018/028
- Hill, R.C., Griffiths, W.E. & Lim, G.C. 2008. *Principles of Econometrics* (3rd ed.). Hoboken, NJ: John Wiley & Sons, Inc.
- Ho, W.K.O. & Ganesan, S. 1998. On land supply and the price of residential housing. *Netherlands Journal of Housing and the Built Environment* 13(4): 439-452
- Ismail, S., Wai, C.C.W., Hamid, H.A, Mustapha, N.F, Ho, G., Theng, T.T., Kamaruzuki, M.N. & Firouz, A.M.M. 2019. *Rethinking Housing: Between State, Market and Society: A Special Report for the Formulation of the National Housing Policy (2018-2025), Malaysia*. Kuala Lumpur: Khazanah Research Institute
- Kahn, J.A. 2008. *What Drives Housing Prices?* Federal Reserve Bank of New York Staff Report No. 345
- Koehler, A.B. & Murphee E.S. 1988. A comparison of the Akaike and Schwarz criteria for selecting model order. *Journal of the Royal Statistical Society: Series C (Applied Statistics)* 337(2): 187-195
- Lean, H.H. & Smyth, R. 2014. Dynamic interaction between house prices and stock prices in Malaysia. *International Journal of Strategic Property Management* 18(2): 163-177
- Mat Zin, I. 2001. Kes ragut dikenal pasti kerap berlaku di penempatan setinggan. Utusan Online. [http://ww1.utusan.com.my/utusan/info.a.sp?y=2001&dt=0409&pub=Utusan\\_Malaysia&sec=Laporan\\_Khas&pg=lk\\_05.htm](http://ww1.utusan.com.my/utusan/info.a.sp?y=2001&dt=0409&pub=Utusan_Malaysia&sec=Laporan_Khas&pg=lk_05.htm) (accessed 2 October 2018)
- Mian, A. & Sufi, A. 2014. *House Price Gains and US Household Spending from 2002 to 2006*. National Bureau of Economic Research Working Paper No. 20152
- Meth, P. 2012. Informal housing, gender, crime, and violence: The role of design in urban south Africa. *British Journal of Criminology* 57: 402-421.
- Nakajima, M. 2011. Understanding house-price dynamics. *Business Review, Federal Reserve Bank of Philadelphia, Issue Q2*: 20-28.
- National Property Information Centre. 2016. The Malaysian House Price Index. (accessed 15 September 2018)
- Perron, P. 1989. The great crash, the oil price shock, and the unit root hypothesis. *Econometrica* 57: 1361-1401
- Pesaran, M.H. & Pesaran, B. 1997. *Working with Microfit 4.0: Interactive Econometric Analysis*. Oxford: Oxford University Press.

- Pesaran, M. & Shin, Y. 1999. An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis. In *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium* edited by S. Ström. Cambridge: Cambridge University Press.
- Pesaran, M.H., Shin, Y. & Smith, R.J. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16: 289-326
- Piazzesi, M. & Schneider, M. 2009. Momentum traders in the housing market: Survey evidence and a search model. *American Economic Review* 99(2): 406-411
- Ramsey, J.B. 1969. Tests for specification errors in classical linear least-squares regression analysis. *Journal of the Royal Statistical Society. Series B (Methodological)* 71: 350-371.
- Sabyasachi, T. 2019. *Macroeconomic Determinants of Housing Prices: A Cross Country Level Analysis*. Munich Personal RePEc Archive Paper No. 98089.
- Shiller, R. J. 2016. *Irrational Exuberance*. Princeton: Princeton University Press.
- Sukri, N.N.A.N.M., Wahab, N.A. & Yusof, R.M. 2019a. An enhanced house price index model in Malaysia: A Laspeyres approach. *International Journal of Economics, Management and Accounting* 27(2): 373-396
- Sukri, N.N.A.N.M., Wahab, N.A. & Yusof, R.M. 2019b. Constructing an enhanced house price index model: empirical evidence. *Jurnal Ekonomi Malaysia* 53(3): 117-128
- Stroebel, J. 2015. How do rising house prices affect the local economy? <https://www.weforum.org/agenda/2015/01/how-do-rising-house-prices-affect-the-local-economy/> (accessed 14 November 2018)
- Sutton, G.D. 2002. Explaining changes in house prices. *Bank of International Settlements Quarterly Review*: 46-55.
- Trofimov, I.D., Nazaria, M.A. & Xuan, D.C.D. 2018. *Macroeconomic and Demographic Determinants of Residential Property Prices in Malaysia*. Munich Personal RePEc Archive Paper No. 85819
- Tsatsaronis, K. & Zhu, H. 2004. What drives housing price dynamics: Cross-country evidence? *Bank of International Settlements Quarterly Review*: 65-77.
- World Bank Open Data. 2018. GDP per Capita, current USD (Data File). <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD> (accessed September 2018)
- Zaemah, Z. 2010. *An Empirical Analysis of Malaysian Housing Market: Switching and Non-Switching Models*. PhD thesis, Lincoln University, New Zealand.
- Saizal Pinjaman\*  
Faculty of Business, Economics and Accountancy  
Universiti Malaysia Sabah  
Jalan UMS, 88400 Kota Kinabalu, Sabah  
MALAYSIA  
E-mail: saizal@ums.edu.my
- Mori Kogid  
Faculty of Business, Economics and Accountancy  
Universiti Malaysia Sabah  
Jalan UMS, 88400 Kota Kinabalu, Sabah  
MALAYSIA  
E-mail: edy@ums.edu.my
- \*Corresponding author