

Constructing an Enhanced House Price Index Model: Empirical Evidence (Membina Model Indeks Harga Rumah yang Dipertingkatkan: Bukti Empirik)

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ABSTRACT

The objective of this study is to construct an enhanced house price index model in Malaysia. Having reviewed the current model of the Malaysian House Price Index (MHPI), it is currently found that this index is constructed based on the demand-driven variables. Previous studies explained that both macroeconomic factors (income levels, interest rates, and labor market) and supply factors are included in the construction of the house price index. This study begins by examining the determinants of the existing house price index in Malaysia. This study employs the Autoregressive Distributed Lag Model (ARDL) to discover the short and long-run dynamics between the variables. The study considers the quarterly data from the first quarter of 2008 to the fourth quarter of 2017. The findings reveal that construction cost (CC) and housing loan (HLN) are significant in determining HPI while Overnight Policy Rate (OPR) and land supply (LS) are insignificant with HPI. Then, the housing loan was found to be the most significant variable in determining HPI in Malaysia. Hence, we propose a new enhanced house price index that incorporates new demand and supply variables, by using the Laspeyres approach to calculate the new enhanced HPI. The analysis shows that the enhanced house price index has also recorded the same trend but with a lower value of prices as compared to the current MHPI. This enhanced HPI model may reflect the real situation of the housing market in Malaysia and it is expected to increase the affordability of the society in fulfilling their basic needs. This study may provide evidence for the involved parties to have some policy ramifications to further monitor and take appropriate measures to control the prices of property.

Keywords: House price index; Malaysia; Laspeyres Approach

ABSTRAK

Kajian ini bertujuan untuk membangunkan model baharu bagi indeks harga rumah di Malaysia. Kajian ke atas model indeks harga rumah sedia ada di Malaysia menunjukkan bahawa indeks harga rumah dibina berdasarkan kepada faktor dari sudut permintaan sahaja. Kajian terdahulu mendapati bahawa kedua-dua faktor makroekonomi (tahap pendapatan, kadar faedah dan pasaran buruh) dan faktor penawaran perlu dimasukkan dalam pembinaan model harga rumah. Justeru, kajian ini dimulakan dengan mengkaji penentu indeks harga rumah yang sedia ada di Malaysia. Kajian ini menggunakan kaedah auto regresif lat tertabur (ARDL) untuk mengenal pasti sama ada terdapat hubungan jangka pendek dan jangka panjang di antara pemboleh ubah. Data yang digunakan dalam kajian ini adalah dari suku pertama tahun 2008 sehingga suku keempat tahun 2017. Hasil kajian menunjukkan bahawa pemboleh ubah seperti kos pembinaan dan pinjaman perumahan adalah penting dalam menentukan indeks harga rumah. Manakala tanah dan kadar dasar semalaman (OPR) adalah tidak signifikan dalam mempengaruhi indeks harga rumah. Selain itu, pinjaman perumahan adalah pemboleh ubah yang paling signifikan dalam menentukan harga rumah di Malaysia. Justeru, kajian ini mencadangkan pembinaan semula indeks harga rumah baharu yang dengan menggabungkan pemboleh ubah daripada faktor permintaan dan penawaran dengan menggunakan model Laspeyres. Hasil kajian menunjukkan bahawa indeks harga rumah yang baharu ini mencatatkan tren yang sama dengan indeks harga rumah sedia ada tetapi dengan nilai harga yang lebih rendah. Model HPI yang baharu ini mungkin mencerminkan keadaan sebenar pasaran perumahan di Malaysia dan diharapkan dapat meningkatkan kemampuan masyarakat dalam memenuhi keperluan asas mereka. Kajian ini boleh memberi petunjuk kepada pihak-pihak yang terlibat untuk mewujudkan beberapa dasar yang bersesuaian dalam memantau dan mengambil langkah yang sewajarnya untuk mengawal harga hartanah.

Kata kunci: Indeks harga rumah; Malaysia; Model Laspeyres



INTRODUCTION

The increase in house prices has become a worrying issue and has received attention from many people. It is affecting homeownership affordability among the different levels of people such as the lower and middle-income groups. Buying a house will be one of the biggest decisions made by many households and that decision should be guided by appropriate and reliable information on the movement of the rate of price change. Due to this, most of the developed countries have produced their own house price index to monitor price changes.

As for Malaysia, the National Property Information Centre (NAPIC) introduced the first Malaysian House Price Index (MHPI) in 1997, using 1990 as the base year. This index is used as a benchmark on the housing market performance in Malaysia. It consists of about 123 series of quarterly and annual data of house price index that are derived for 46 districts and 14 states in Malaysia (NAPIC 2018).

The hedonic method is adopted by NAPIC to construct the MHPI. This method has been widely used in the construction of house price indexes. The hedonic method has been applied in the construction of house price index in the United States (US) as early as 1982, and in the United Kingdom (UK) since 1983. Through this method, the house price will be valued based on its characteristics such as the number of rooms, size, land area and etc. (Rosmera et al. 2012). Then, the MHPI is computed by using variables such as land area, floor area, building age, distance to amenities, floor level (for high rise unit only), housing types, quality of the building, tenure type and neighborhood classification (NAPIC 2018). Table 1 below describes the factors that are used in a principal component analysis of neighborhood study.

By reviewing all the variables listed in the table above, it can be seen that most determinants that have been included in the construction of the house price index in Malaysia are only based on the demand side. This determinants are divided into three categories- the physical and environmental factors (e.g. scheme age, location, distance, number of bedrooms and bathrooms), social factors (ethnic structure, quality of the surrounding neighborhood and type of land use in the surrounding) and economic factors (income, occupancy level and frequency of property turnover).

The house price index is driven by the interaction between demand and supply factors. However, it is found

that the construction of HPI in Malaysia is fundamentally based only on the demand side variables. Several studies have pointed out that the supply factors are also important in determining the house price index. (Liew & Haron 2013; Dröes & Minne 2015; Osmadi et al. 2015). In the long run, house prices tend to respond to the construction cost (land cost, materials and labor cost, associated financing and consenting cost) while an increase in land supply can bring down the house prices. Past literature has also shown that land supply has a significant effect on house prices both in the long run and in the short run. The interaction between these demands and supply factors will determine the equilibrium of the house price index (Yan et al. 2010; Glindro et al. 2011; Craig & Hua 2011).

To date, there is only one house price index that is available in Malaysia and it serves as the main reference to various groups such as for the policymaker and also the public. Due to this, a comparable HPI is not available for comparison in order to determine the accuracy of the index. Only a few studies have been carried out to construct an alternative house price index in Malaysia. Nevertheless, it is only focused on microeconomic variables or hedonic characteristics are to be included in the new house price index model (Rosmera et al. 2012; Lizam et al. 2013; Lizam et al. 2014; Tan 2011). By reviewing the previous literature, a comprehensive model on HPI which takes into account the macroeconomic factors (demand side) and supply factors, has not been developed. Hence, the aim of this study is to identify what are the significant determinants of the existing house price index. This is because it is very important to determine the determinants that give a high impact on the house price index. Correspondingly, this study proposed that the house price index be enhanced to be inclusive of new demand and supply factors. It is assumed that other supply factors will also significantly influence the HPI in Malaysia.

This study contributes to the policymakers and the literature in the following ways. First, to the policymakers, the house price index is intended to provide policymakers with some ideas about the real estate market conditions, which will be used to monitor house price changes (Mansor 2012). Furthermore, this index can also be used as a guide for the policymakers in determining the profit rate and also in setting the minimum and maximum price. Besides that, the establishment of the benchmark may also help policymakers and regulators to ensure that fraud and manipulation do not occur in

TABLE 1. Factors Used in Analysis of Housing Neighbourhood Study

Economic Factors	Social Factors	Physical and Environmental Factors
(e.g: Household Income, Occupancy level, Frequency of Property Turnover/ Transaction)	(e.g: Ethnic Structure, Quality of Neighbourhood in the Surrounding, type of land use in the surrounding.)	(e.g: Location, Accessibility to city, school, shopping complex and others, number of housing units, number of bathrooms and bedrooms, etc., drainage, scheme age, availability and types of public transport)

Source: NAPIC 2018.

the market, hence creating a healthy market in line with the principles outlined in the Shariah. Consequently, this can promote social justice and fairness in financial transactions to the buyer as well as to the bank (Omar et al. 2010). Second, this study addresses important gaps in the current knowledge and existing literature on the house price index in Malaysia. For instance, there are only a few studies at present on the house price index in Malaysia, that focus more on the demand side variables (Rosmera et al. 2012; Lizam et al. 2013; Lizam et al. 2014; Tan 2011). However, Tsai (2012) has explained that the housing price index is influenced by both supply and demand, which also affect the supply and demand for housing. The interaction between these demand and supply factors will determine the equilibrium of the house price index (Osmadi et al., 2015; Yan et al. 2010; Glindro et al. 2011; Craig & Hua 2011). The analysis from this study should help to shed light on these areas. The next section of this paper discusses the literature review. This is followed by the research methodology that is employed in this study. Accordingly, this study also discusses the results and findings, and lastly the conclusion.

LITERATURE REVIEW

A credible house price index is important in order to find which determinants are actually contributing and are significant to the house price. A lot of studies that are related to the construction of house price index have been conducted in order to improve the modeling of house price index with the purpose to produce an accurate house price index (Bourassa et al. 2004; Longford 2009; Nagaraja et al. 2010; Selim 2008; Ali & Metin 2011; Lizam et al. 2013).

House price index has long been implemented in developed countries such as the United States of America (US), United Kingdom (UK), Canada and Germany. Based on Lim and Pavlou (2007) the application of the house price index in the UK could be seen as early as 1973. Meanwhile, the US has also produced a house price index in 1975 due to the need to monitor the real estate price changes (Rosmera et al. 2012). The house prices index is also widely available in other countries such as Australia, Germany, South Korea, Thailand, China, Canada, and so forth. In Malaysia, the house price index has been introduced in 1997 by NAPIC which is known as MHPI (Norhaya et al. 2008). It has been used as a benchmark for all parties including investors, financial institutions, researchers and developers (Rosmera et al. 2012).

The construction of house price indexes can be carried out using the repeat sales method, the assessment method, and the hedonic model. In the repeated sales method, the house price index is being measured using houses that are sold more than once. This method has been developed by Palmquist (1980). Nevertheless, the drawback of this method is that the changes in the quality

of the houses due to renovation are not being captured (Guðnason & Jónsdóttir 2008). The second method, which is the assessment method, builds the house price index by taking the difference between the valuation of a house and its sales price (Guðnason & Jónsdóttir 2008). Thus, the information about the characteristics of housing is not relevant to this model. This type of house price index is established in New Zealand, Denmark, Sweden, and the Netherlands (Vries et al. 2009; Bourassa et al. 2004; Elmahmah 2012). Lastly, many countries are using the hedonic price model due to the reliability of the indexes in capturing the market condition. Elmahmah (2012) mentions that this method can track over time the real value of a sold property and allows the valuation of property in view of their characteristics.

According to Tsai (2012), the housing price index (HPI) is affected by both supply and demand, which also affect the supply and demand for housing. The house price can be determined based on the macroeconomic (market-related) factors and microeconomic (house specific) factors. Previous studies have explained that the house price index is derived by the demand factors (e.g., income, trend of labor market, demographic and credit availability) and the supply factors (e.g., Construction cost, land supply index and geographical constraint) (Mohan et al. 2019; Li et al. 2018; Yan et al. 2010; Glindro et al. 2011; Craig & Hua 2011). Meanwhile, house prices are also strongly related to other microeconomic house-specific demand factors such as physical, structural, location, environmental and the neighborhood (Zhang & Yi 2017; Stohldreier 2012; Ong & Chang 2013; Tan 2011; Md Yusof 2008). Table 2 below shows the determinants for house price index from selected countries.

Table 2 above shows the determinants that are used by selected countries to calculate the house price index. A study by Chen et al. (2013) has exposed that the Beijing house price index is significantly influenced based on the economic fundamental variables such as inflation, income, interest rate, and the construction cost from 2004 to 2007. Similar to Hou (2010) who has revealed that about 75 percent of the changes in Beijing house prices is explained by the economic variables used in the models. Besides that, the house price index in Korea is computed based on the total factor of construction cost including land and personal disposable income for single-family dwelling and apartments (KB Financial Group Inc. 2012). The ranking of the house price index in Korea is lower as compared to Malaysia (Knight Frank 2015). By reviewing the determinants that influenced the house prices index in Beijing and Korea, it is shown that both the demand and supply factors play a significant role in determining the house price index.

Moreover, another study that has been conducted by Eurostat (2013) has described the important elements that are used to compute the Residential Property Prices Indices (RPPI), which includes the area of structure, land

TABLE 2. Determinants for House Price Index from Selected Countries

	Malaysia	Korea	China	Germany	European Union
Physical and Environmental	✓	✓		✓	✓
Structural				✓	✓
Neighborhood/Social factors	✓			✓	
Location	✓	✓		✓	✓
Income	✓	✓	✓		
Level occupancy	✓				
Frequency of property turnover	✓				
Building cost/Construction cost		✓	✓	✓	
Land Supply		✓			
Materials used in the construction (wood, brick etc.)					✓
Inflation			✓		
Interest rate			✓		
Housing loan				✓	

Source: Compilation from Various Sources

area, location, property type and age, material used in the construction of the house (wood, brick, concrete and etc.) and other house price characteristics such as the number of bedrooms and bathrooms, distance to amenities and others. Other than that, Duebel (2012) has explained the attributes that are used in the construction of the house price index in Germany which includes the physical, structural, neighborhood and social, location and construction cost factors. All the factors comprise both the demand and supply side.

Nevertheless, in Malaysia, most of the variables that are used to construct the house price index are only based on demand factors. This includes the physical, social, environmental, income, level of occupancy and frequency of property turnover (NAPIC 2017). Besides that, only a few studies have been carried out to construct an alternative house price index in Malaysia. Nevertheless, it is only focused on microeconomic variables or hedonic characteristics which are to be included in the new house price index model. Rosmera et al. (2012) and Lizam et al. (2013) have proposed an alternative house price index to be used as one of the references in monitoring price changes. It is called a hypothetical price index. The variables used in this study include physical and locational characteristics of the property. The analysis shows that the hypothetical price index shows the same trend as the MHPI. Only in certain quarters, the index is different. It might be due to the different samples of data.

Besides that, Ong and Chang (2013) review the determinants of house prices in Malaysia using the macroeconomic factors from the year 2000 until the middle of 2012. The findings show that only the real GDP rate is significant to the house price index compared to the consumer price index and income increment rate. The strong economic growth (GDP) in recent years has become a reason for the increasing housing price index in

Malaysia. It is supported by Md Yusof (2008) who reveals that the movement for more than 80 percent of house price index variations for every model in Malaysia is explained by GDP. Conversely, a study by Pillaiyan (2015) has claimed that the GDP is not determined as a driver for long term house prices while the other determinants such as inflation, Malaysian stock market, money supply (M3) and the number of residential loans approved are strongly related with the MHPI. On the other hand, Tan (2011) uses the hedonic model to analyze the determinants that are correlated with house prices in Malaysia. Based on the analysis, income per capita, unemployment rate, total loans, and KLSE CI are found to be significant with the house prices.

Previous studies have exposed that the supply factors also give an impact on the movement of house prices (Xu & Tang 2014; Osmadi et al. 2015). From the supply side, the determinants that influence house prices can be classified into land supply index, planning policy and construction costs. Existing literature on house prices have shown that a number of researchers have also include the cost of construction and land supply as important components of the supply side variables (e.g. Dröes & Minne 2015; Madsen 2011; Capozza et al. 2002; Yan et al. 2010; Glindro et al. 2011; Craig & Hua 2011). An increase in the construction cost will have a major influence on the rise of house prices. The higher financial cost of construction will reduce construction and housing stocks, the lower level of housing space will then increase the rents and house prices (Xu & Tang 2014; Liew & Haron 2013; Osmadi et al. 2015; Watson 2013).

In the long run, house prices tend to respond to the construction cost (land cost, materials and labor cost, associated financing and consenting cost) while an increase in land supply can bring down the house prices. Past literature has also shown that land supply has

a significant effect on house prices both in the long run and in the short run. Generally, housing prices are more flexible in the business environment but more unstable in housing markets (Yan et al. 2010; Glindro et al. 2011; Craig & Hua 2011).

Several attempts have been made to include the supply factors (cost of construction) into the construction of the house price index model in Malaysia (Liew & Haron 2013; Osmadi et al. 2015). Based on Liew and Haron (2013), the most influential factors behind the increase in house prices in the Klang Valley area due to the rising of construction costs. This cost land price, high technology, and heavy machinery, materials, project period, difficulty in building and labor. Besides that, the cost of material and land are also important in determining the house price in Malaysia (Osmadi et al. 2015). According to Bank Negara Malaysia (2007), the national house prices as measured by the Malaysian House Price Index had increased by 3.8 percent in the first half of 2007. The rising cost of building material is found to be one of the components that influence the increase in house prices in Malaysia.

The interaction between these demand and supply factors will determine the equilibrium of the house price index. This will be more representative of the housing market in the country. A number of studies have considered physical, structural, location and neighborhood factors as being important in determining house prices (NAPIC 2018; Zhang & Yi 2017; Chen et al. 2013; Eurostat 2013; Duebel 2012). Meanwhile, Tsai (2012) explains that both demand and supply factors should be incorporated into the computation of the house price index because the HPI is affected by both supply and demand factors.

As for Malaysia, there are other important variables that might not have been included in the computation of the HPI. So, this study fills the gap in the literature by developing a more comprehensive analysis to identify the determinants influencing the HPI, based on demand and supply factors.

DATA AND METHODOLOGY

DATA

The aim of this study is to construct an enhanced HPI model in Malaysia and at the same time to investigate the significant determinants of the HPI in Malaysia. In doing so, the secondary data has been employed to cover the period of 2008:Q1 to 2017:Q4. Data is extracted from various sources, namely NAPIC, BNM, and CIDB. The measurements of variables that are used in this study are summarised in Table 3.

Table 3 depicts the proxies and sources of the variables that are used in this study. Since CC and LS are the supply factors that have been widely used in the

TABLE 3. Measurement of Variables

Variables	Measurement	Sources
House Price Index (HPI)	Malaysian House Price Index	NAPIC
Construction Cost (CC)	Building Material Cost Index	CIDB
Land Supply (LS)	Housing Permit Approvals	BNM
Housing Loan (HLN)	Housing Loan Approved	BNM
Interest rate	BNM Overnight Policy Rate (OPR)	BNM

Note: All variables are collected from 2008:Q1 to 2017:Q4.

literature, we include both variables in our analysis as the determinants of the HPI.

METHODOLOGY

This study aims to construct an enhanced house price index model. Hence, the determinants of the existing HPI in Malaysia were examined using the Autoregressive Distributed Lag (ARDL). The coefficients computed in the ARDL model were later used to calculate the enhanced HPI using a Laspeyres Approach. The details of the methodology that have been used in this study are explained below:

a) Unit Root Test

In time series, stationarity of variables is important for estimation. Using least squares regressions on non-stationary variables can give incorrect parameter estimates of the relationships between variables. Testing using ordinary least squares (OLS) may result in spurious regression in which the findings show that the model is a match and there is a statistically significant relationship between variables where none actually exists. For macroeconomic variables, it is very common to find a non-stationary series.

In this study, a unit root test is used to verify whether all the selected variables are stationary at level $I(0)$ or stationary at first difference $I(1)$. The existence of a unit root indicates that a particular variable is not stationary. This study applies the Augmented Dickey-Fuller (ADF) test in order to test for the presence of a unit root in all variables. The regression of ADF serves to solve the problem of serial correlation at the first differences. The stationarity analysis has been tested towards all the selected variables in this study (GDP, OPR, construction cost, land supply, and housing loan).

b) Autoregressive Distributed Lag (ARDL)

This analysis used the bound testing and autoregressive distributed lag (ARDL) model which was developed by

Pesaran et al. (1996). The cause of selecting this technique is because it is relatively simple and does not require all variables to be $I(1)$ like Johansen. Besides, this technique is also more effective for a small sample such as the data for this study has 40 observations only. In addition, Narayan (2005) reaffirms that the ARDL model approach is efficient and unbiased. At the same time, the ARDL cointegration model is also able to capture the short-run and long-run components of the model simultaneously.

Generally, ARDL requires a standard procedure that comprises a stationary test and a cointegration test. A stationary test can be done through a unit root test while the cointegration test can adopt the ARDL bound testing approach. ARDL bounds testing approach requires several steps. Firstly, the Error Correction Model (ECM) procedure will be used to identify whether there is cointegration between the selected variables or not. Then, the bound test will be conducted by selecting a higher lag length. In this study, the sample period covers from Q1 2008 to Q4 2017 (40 observations). In order to avoid the over parameter problem, the analysis starts with the minimum lag order 1.

Secondly, after specifying the optimum lag model, the test will proceed with the ARDL cointegration bounds test. Then, the long-run relationship between the house price index and the selected variables need to be estimated. As the value of our F-statistic exceeds the upper bound at the 1% significance level, it can be concluded that there is evidence of a long-run relationship between the three time-series. Lastly, the analysis has to check for serial correlation, functional form, normality, and heteroscedasticity by using the residual diagnostic test.

Based on the hedonic method that has been formalized by Rosen in 1974, multiple regression is employed to model the HPI. Fundamentally, the application of the regression analysis in the method helps one to determine the attributes that give a high impact on the property values. Thus, one can differentiate which attribute actually contributes to the house prices. In this study, the dependent variable is the house price index whilst the independent variables are OPR, CC, LS, and the housing loan. The ARDL model that has been used in this study can be articulated as follows:

$$HPI_t = \alpha_0 + \alpha_2 OPR_t + \alpha_3 CC_t + \alpha_4 LS_t + \alpha_5 HLN_t + e_t \quad (1)$$

- OPR = Overnight Policy Rate
- CC = Construction Cost
- LS = Land Supply
- HLN = Housing Loan
- e_t = Error term

c) ARDL Bound Testing Cointegration Approach (Long-run Analysis)

There are a few numbers of cointegration techniques that allow an empirical test for the existence of long-

run relationships among variables. One of the most common approaches that can be used is the autoregressive distributed lag (ARDL) model that has been introduced by Pesaran et al. (1996). On the other hand, ARDL can also be used to reliably test hypotheses on coefficients when the variables are $I(0)$ or $I(1)$.

The ARDL approach to cointegration involves estimating the conditional error correction (EC) (Pesaran et al. 2001). In this technique, the criteria information like Akaike Information Criterion (AIC), Schwarz Information Criterion (SAC) or Bayesian Information Criterion (BAC) can be applied to select the optimum lag for the model or appropriate lags for ADF test. Taking all these into consideration, the ARDL model is chosen as appropriate for this study.

The ARDL model for house price index and its determinants are:

$$\begin{aligned} \Delta \ln HPI_t = & \alpha_0 + \sum_{j=1}^{k1} b_j \Delta \ln HPI_{t-j} + \sum_{j=0}^{k2} c_j \Delta OPR_{t-j} + \\ & \sum_{j=0}^{k3} d_j \Delta \ln CC_{t-j} + \sum_{j=0}^{k4} e_j \Delta \ln LS_{t-j} + \\ & \sum_{j=0}^{k5} f_j \Delta \ln HLN_{t-j} + \beta_1 HPI_{t-1} + \beta_2 OPR_{t-1} + \\ & \beta_3 \ln CC_{t-1} + \beta_4 \ln LS_{t-1} + \beta_5 \ln HLN_{t-1} + \varepsilon_t \quad (2) \end{aligned}$$

The variables used in this study are OPR (overnight policy rate), CC (construction cost), LS (land supply) and HLN (housing loan). The error-correction dynamics are represented by the terms with the summation signs, while the long-run relationship is represented by the second part. The k represents the maximum number of lags in levels of the variables, Δ is the first difference operator, and α_0 is constant. E_t refers to the random error term.

The bound test is employed in this study to test the existence of long-run cointegration between the OPR, construction cost, land supply and housing loan with dependent variables (house price index). Bound testing techniques consists of four steps. The first step is to ascertain the existence of cointegration or long-run relationship among the variables that are based on estimating the error correction models (ECM). Once it is confirmed that there is cointegration, the second step is to estimate the long-run relationship between the selected variables (OPR, CC, LS, HLN) and the house price index using the selected ARDL models. The third step is to estimate the associated ARDL ECM. Lastly, a diagnostic and stability testing is carried out to determine the goodness of fit of the ARDL models.

Based on the equation 2, the null hypothesis ($H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$) states that there is no existence of long-run relationship being tested against the alternative hypothesis ($H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 = 0$), that states there is the existence of long-run relationship. Narayan (2005) provides two sets of critical values of

bound. The first one assumes that all the independent variables are significant at $I(1)$ while the other set assumes that all the independent variables are significant at $I(0)$. The lower critical value of the bounds test assumes the regressors are $I(0)$ and the upper value assumes the regressors are $I(1)$. Hence, the result of the F -statistics test has explained that if the result exceeds the upper bound, the null hypothesis is rejected while the null hypothesis cannot be rejected if the computed value F -test is less than the lower bound. On the other hand, if the computed value of the F -test falls within the lower and upper bound, then the test is inconclusive. Pesaran et al. (2001) explain that if this case occurs, the inconclusive test requires further investigation on the integration order of all the variables to ensure that the variables are not integrated at the second-order ($I(2)$).

d) Short run Analysis

The Error Correction Model (ECM) reflects the error-correction parameter. The coefficient on the error correction term is expected to be between -1 and 0. The ECM coefficient shows the speed of the adjustment process to restore equilibrium following a disturbance in the long-run equilibrium relationship. A significant negative ECM coefficient suggests how fast the variables return to equilibrium. A relatively high ECM coefficient in the absolute amount indicates a quicker adjustment process. By using ARDL methodology, this study incorporates ECM analysis to empirically explore the short run in selected variables (i.e., OPR, construction cost, land supply, and housing loan) on Malaysia's House Price Index.

$$\begin{aligned} \Delta \ln HPI_t = & \alpha_0 + SECT_{t-1} \sum_{j=1}^{k1} b_j \Delta \ln HPI_{t-j} + \sum_{j=0}^{k2} c_j \Delta OPR_{t-j} \\ & + \sum_{j=0}^{k3} d_j \Delta \ln CC_{t-j} + \sum_{j=0}^{k4} e_j \Delta \ln LS_{t-j} \\ & + \sum_{j=0}^{k5} f_j \Delta \ln HLN_{t-j} + \varepsilon_t \end{aligned} \quad (3)$$

The model of short-run dynamic is written in equation (3), which is represented by the first difference equation, and the error correction term (ECT). The coefficient of error correction term, that is measures the speed of the adjustment that stabilizes disequilibrium of the model by converging to equilibrium. In equation (3), k is the maximum number of lags in difference form model, Δ is the first difference operator, and ε_t is the error terms.

e) Constructing a new House Price Index Using Laspeyres approach

In this study, an enhanced house price index in Malaysia has constructed the using Laspeyres approach. This method is also applied by NAPIC to compute price indices for Malaysia. For each quarter period, NAPIC will compute

the regression coefficients and they are used to calculate the current period index number by using the fixed-weight Laspeyres formula. The computation of price indices has been structured so that the index number equals 100.0 in the base year (2010) (NAPIC 2017).

The Laspeyres approach is an index formula that is used in price statistics for measuring the price development of the basket of goods and services that are consumed in the base period. This method is a way of expressing how prices today are compared with prices at some point in the past. The Laspeyres index has the following form:

$$I = \frac{\sum P_n W}{\sum P_o W} \quad (4)$$

Where:

$\sum P_n W$ = sum of weighted current prices for each variable
 $\sum P_o W$ = sum of weighted base prices

According to the Australian Bureau Statistics (2011), the advantage of the Laspeyres approach is that the index can be extended to include another period's price observations when available, as the weights are held fixed at some earlier base period. Therefore, only prices have to be collected on a regular basis. It is much less costly and time-consuming to calculate a time series Laspeyres index than a time series of Paasche, Fisher, and Törnqvist price indexes.

The main characteristic of the Laspeyres index is that the weights that are used are taken from the base period. So, in this study, the first quarter (Q1) of 2008 is selected as a base year for the analysis. In practice, quantities might not be observable or meaningful for some indexes. Thus, in practice, the Laspeyres formula can be estimated using value shares to weight price relatives. If price relatives are used then value weights must also be used. On the other hand, if prices are used directly rather than in their relative form, then the weights must be quantities.

For this study, the new enhanced house price index is developed based on the researchers' calculation using the Laspeyres formula according to the weights so that the house price index that is currently published by the National Real Estate Research Coordinator (NAPREC) will be more reflective of the macroeconomic fundamentals as well as housing market variables. The variables (overnight policy rate, construction cost, land supply, and housing loan) are used to compute the enhanced house price index. Firstly, the house price index is modeled using multiple regression techniques. Secondly, in order to test this relationship, this study has proposed the use of ARDL analysis. The application of regression analysis using ARDL will help to determine the significant variables that give a significant impact on house prices. After that, the value of the coefficient from the long-run analysis is used to calculate the weighted,

for each selected variable. The weighted times with the prices of each selected variable will derive an index value for each year. Consequently, for each quarter period, these weighted are used to calculate the new enhanced house price index number using the Laspeyres approach. Then, the computation of house price indices has been structured so that the index number equals 100.0 in the base year (Q1 2008).

FINDINGS AND ANALYSIS

This section discusses the results of the methodology that has been used in this study. We have first tested the descriptive analysis of this study and the results are presented in Table 4 below, then the stationarity of all the variables that are used have been tested by using a unit root test. The results of the methodology that has been used are discussed in the following sub-section.

a) Descriptive Analysis

TABLE 4. Summary of Descriptive Analysis

	LNHPI	OPR	LNCC	LNLS	LNHL
Mean	4.905695	2.962500	95.82625	10.46847	7.717188
Median	4.882800	3.000000	98.38500	10.43610	7.605900
Maximum	5.270400	3.500000	107.8500	11.25860	9.158800
Minimum	4.529400	2.000000	84.29000	9.482426	5.529420
Std. Dev.	0.226269	0.414288	6.992934	0.360333	1.036344
Skewness	-0.045345	-1.162179	-0.348061	-0.463313	-0.246452
Kurtosis	1.833294	3.708043	2.006210	3.411186	2.291526
Jarque-Bera Probability	2.282379	9.839934	2.453675	1.712849	1.241483
	0.319439	0.007299	0.293218	0.424678	0.537546
Sum	196.2278	118.5000	3833.050	418.7389	308.6875
Sum Sq. Dev.	1.996702	6.693750	1907.144	5.063763	41.88636
Observations	40	40	40	40	40

The table of descriptive analysis above shows that the mean and median values for all variables vary with minimal standard deviation and suggests that the data are distributed evenly.

b) Unit Root Test

The unit root test is arguably the most vital test in time series analyses. The test is carried out on all the selected variables to examine the stationarity of the variables. A null hypothesis indicates the presence of a unit root, while an alternative hypothesis indicates the absence of a unit root.

Table 5 displays the results of the unit root test for the variables in the study. It can be concluded that it is consistent with Pesaran et al. (2001), the results suggest

TABLE 5. Summary of Unit Root Test

Variables	I(0) level		I(1) 1 st Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
HPI	0.0920	-5.3120***	-4.2575**	-4.6992**
OPR	-1.9016	-2.3563	-4.1410**	-4.1386*
CC	-0.8406	-2.3478	-5.9199***	-6.0300***
LS	-1.8048	-2.0481	-9.4556***	-9.3282***
HLN	-1.7830	-2.7543	-5.3540***	-5.3663***

Null Hypothesis (H_0): There is a unit root.

***significant at 1 percent level

**significant at 5 percent level

*significant at 10 percent level

that the selected variables are integrated of order 0 or 1 and thus justifies the ARDL co-integration test.

c) Results of the ARDL Bound Testing Cointegration Approach (Long-run Analysis)

The Bound test has been examined by selecting the higher lag length. In this study, the sample period covers from Q1 2008 to Q4 2017 (40 observations). In order to avoid the over parameter problem, the minimum lag order starts with a lag 1.

i) Diagnostic Test

TABLE 6. Serial Correlation LM Test

F-statistic	0.452018	Prob. F(1,9)	0.5183
Obs*R-squared	1.673782	Prob. Chi-Square(1)	0.1958

Table 6 above shows the results for the serial correlation analysis. Since the null hypothesis is that the residuals are serially uncorrelated, the X^2 -statistic p - the value of 0.1958 indicates that this analysis fails to reject this null. It can be concluded that the residuals are serially uncorrelated and the data have no problem of serial correlation.

ii) Heteroscedasticity Test

TABLE 7. Heteroskedasticity Test

F-statistic	1.516311	Prob. F(24,10)	0.2506
Obs*R-squared	27.45551	Prob. Chi-Square(24)	0.2837
Scaled explained SS	2.127740	Prob. Chi-Square(24)	1.0000

Based on table 7 above, it is explained that the X^2 -statistic p -value is 0.2506. It can be concluded that the residuals are homoscedastic.

iii) Bound Test

TABLE 8. Results of Bound Testing Procedure

Cointegration Hypotheses	ARDL Model	F-Statistics
$F(HPI OPR, CC, LS, HLN)$	(5,5,5,3,2)	4.7204***

*Notes: F-statistics exceeds the ***1 percent upper bounds; the relevant critical value bounds are taken from Narayan's (2005). with unrestricted intercept and restricted trend; the number of regressors = 45, number of observations = 40. They are 3.74 – 5.06 at the 1% significance level, 3.25 – 4.49 at the 2.5% significance level, 2.86 – 4.01 at the 5% significance level and 2.45 – 3.52 at the 10% significance level.

Table 8 presents the computed F-statistics for the suggested model. It is shown that there are cointegrating relationships among all the selected variables. The findings also suggest that HPI is significantly influenced by the independent variables in the long run. The next step is to estimate the long-run coefficients of the ARDL model. Table 9 explains the findings for each model.

TABLE 9. Results of Long Run ARDL Model

	Coefficient	SE	Prob.
OPR	-0.0378	0.0427	0.3961
LNCC	0.0124	0.0050	0.0330*
LNLS	-0.0282	0.0583	0.6386
LNHLN	0.1552	0.0293	0.0004***
C	2.8900	0.4727	0.0001***

***significant at 1 percent level

**significant at 5 percent level

*significant at 10 percent level

As is depicted in Table 9, CC and HLN are found to be significantly related to HPI. Besides that, it also shows that in the long run, all the independent variables except OPR and LS are related to HPI. Interestingly, the supply-side factor (construction cost) is found to be significant in determining the HPI. This result is consistent with

Pashardes and Savva (2009) who have found that the increase in construction costs (materials and labor) leads to relative increases in the house price, in the sub-period 1988-1998. Therefore, buyers are going to share the burden of higher real construction costs (Glindro et al. 2011). Andrews (2010) has also found that the 10 percent increase in construction cost is related to a 4 percent increase in real house prices. Meanwhile, the result of housing loan is in line with Li et al. (2018) who found the housing loan for real estate have positive effects on house prices and land supply insignificantly influence the house prices.

d) Results of the Short-run Analysis

TABLE 10. Results of Error Correction Model

Variable	Coefficient	SE	t-Statistic
D(LNHPI(-1))	0.7772	0.2453	3.1680
D(LNHPI(-2))	0.8179	0.2271	3.6014
D(LNHPI(-3))	0.7982	0.1852	4.3108
D(LNHPI(-4))	0.3527	0.0864	4.0829
D(OPR)	-0.0394	0.0260	-1.5159
D(OPR(-1))	-0.0533	0.0247	-2.1591
D(OPR(-2))	0.0250	0.0245	1.0186
D(OPR(-3))	-0.0724	0.0291	-2.4898
D(OPR(-4))	0.0179	0.0182	0.9852
D(LNCC)	-0.0022	0.0017	-1.3079
D(LNCC(-1))	0.0041	0.0018	2.3385
D(LNCC(-2))	-0.0046	0.0024	-1.9484
D(LNCC(-3))	-0.0026	0.0018	-1.4018
D(LNCC(-4))	-0.0062	0.0017	-3.7261
D(LNLS)	0.0459	0.0139	3.2918
D(LNLS(-1))	0.0248	0.0122	2.0286
D(LNLS(-2))	0.0627	0.0147	4.2781
D(LNHL)	0.0214	0.0131	1.6306
D(LNHL(-1))	-0.0396	0.0120	-3.3153
ECT (-1)	-0.4014	0.1250	-3.2131

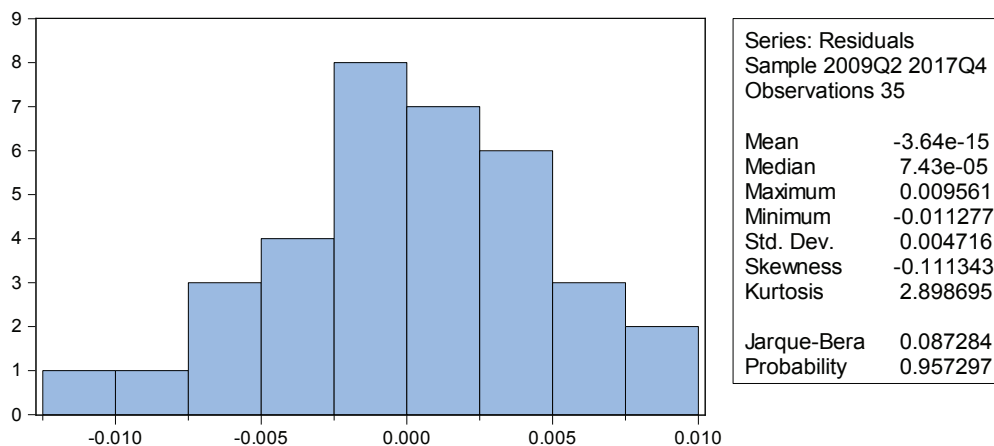


FIGURE 3. Normality Test

Table 10 displays the result for error correction term (ECT) which indicates a negative value with an associated coefficient estimate of -0.4014 . This implies that about 40.14% of any movement into disequilibrium is corrected within one period. Moreover, the t-statistic value -3.2131 also can be concluded that the coefficient is significant.

e) Normality Test

Besides that, the analysis for the normality test shows that the P-value is higher than 0.05, therefore is not significant. Hence the data is normal.

f) Results of the enhanced house price index by using the Laspeyres approach

Figure 4 shows the trend of MHPI that has been constructed by NAPIC and the newly developed enhanced house price index for the period from Q1 2008 until Q4 2017. As depicted, there is an increasing trend of HPI in the Malaysian residential property, while the enhanced house price index has also recorded the same trend but with a lower value of prices as compared to the current MHPI, except in the year 2012. Thus, this suggests that the inclusion of the new variables of demand and supply factors need to be incorporated in determining the HPI in Malaysia for the index to become more reflective of the housing market and the macroeconomic fundamentals in Malaysia. This is because an increase or decrease of MHPI can affect the efficiency and effectiveness of the economy in Malaysia and the decision making of investors and the wealth of households. It is hoped that the newly proposed enhanced house price index serves as a more accurate benchmark for potential developers, investors, house buyers, and sellers to make a strategic economic decision for owning homes or investments.

SUMMARY AND CONCLUSIONS

This study aims to construct an enhanced house price index in Malaysia. A credible and accurate house price index is important in order to accurately measure the changes in house prices. The house price index is driven by the interaction between demand and supply factors. By using the ARDL analysis technique, the selected variables (OPR, construction cost, land supply, and housing loan) from the year 2008 Q1 until 2017 Q4 has been tested.

Based on the analysis, the Malaysian House Price Index (MHPI) was found to have a long run significant relationship with construction cost and housing loan. Interestingly, the supply-side factor of construction cost has been found to be significant in determining the HPI. This is supported by Pashardes and Savva (2009) who have found that the increase in construction costs (materials and labor) leads to relative increases in house prices in the sub-period 1988-1998. Then, buyers are going to share the burden of higher real construction costs (Glindro et al. 2011). Andrews (2010) has also found that a 10 percent increase in construction cost is related to a 4 percent increase in real house prices.

Importantly, the supply factor (construction cost) positively influenced the house price index. Then, the regression coefficients were computed and were used to calculate the current period index number using the Laspeyres approach. The analysis implied that the inclusion of supply variables to be incorporated in determining the HPI in Malaysia is necessary as it would be more accurate to be used as a benchmark for the nation's housing market. The new enhanced house price index portrays the same trend as the existing house price index that is produced by NAPIC, however, with a lower value of price index. This new enhanced house price index captures prices from both the demand and the supply factors. This enhanced HPI model may reflect

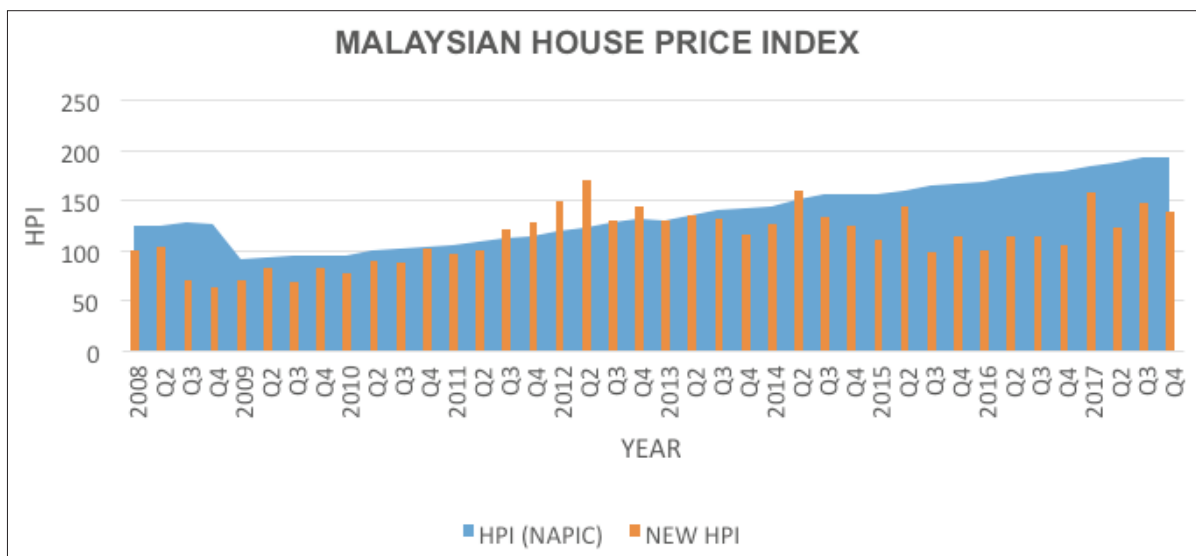


FIGURE 4. The trend of the new house price index and current HPI (NAPIC)

the real situation of the housing market in Malaysia and it is expected to increase the affordability of the society in fulfilling their basic needs. Thus, this study has highlighted that by incorporating both the demand and supply attributes of house prices, the results of the study will contribute towards determining the true value of house prices which will ensure a more stable, affordable, and fair housing prices. Besides that, this paper may provide evidence for the involved parties to have some policy ramifications to further monitor and to take appropriate measures to control the property prices.

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