Int. Journal of Economics and Management 12 (2): 523-535 (2018)

IJEM
International Journal of Economics and Management
Journal homepage: http://www.ijem.upm.edu.my

The Nexus Between Residential Property Prices, Bank Lending, Construction Output and Interest Rate: Policy Lessons from Malaysia

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ABSTRACT

Using the aggregate and disaggregate dataset of various types of housing loan, this study examines the dynamic relationship between residential property prices, housing loan, construction output, and interest rate. Focusing on the aggregate data, it is noted that housing loan, construction output, and interest rate have significant and positive elasticities towards house prices in both short and long-term. The aggregate loan model indicates that about nine quarters or two years are required for full adjustment of house prices after experiencing a shock. Across the loan categories, first, the empirical analysis indicates that there is still a strong demand and potential opportunities for affordable properties. Second, homebuyers who purchase high-end properties will still borrow. Third, there is a significant and positive impact of interest rate on house prices in both short- and long-run, however, albeit a low percentage. The results of the error correction model imply the house prices for low-end housing loans take a longer period (8 to 10 percent quarterly) to return to equilibrium following a shock, compared to house prices for high-end housing loans (11 to 15 percent quarterly). The policymakers should review the housing policies by focusing more on low and the medium housing which is more affordable for the population.

JEL Classification: O18, R21, R28, R31

Keywords: House prices, Aggregate loan, Disaggregate Loan, Housing loan, Construction output,.

Article history:
Received: 17 Mac 2018
Accepted: 4 November 2018

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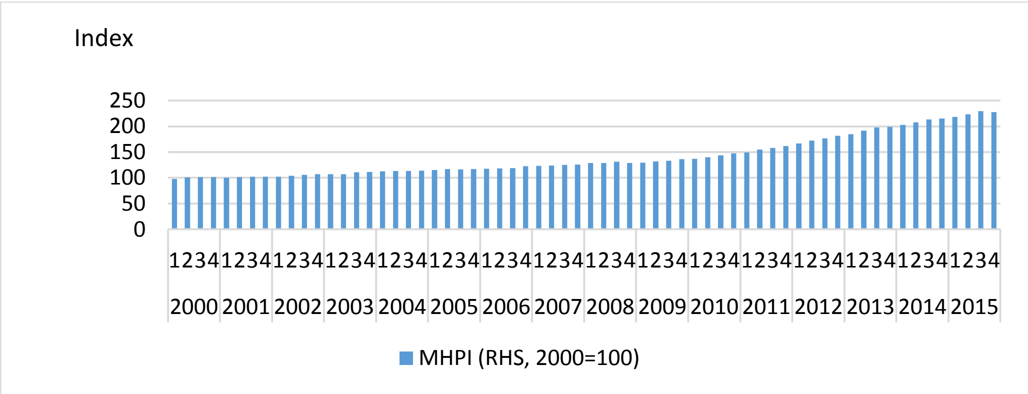
INTRODUCTION

The affordability of the residential property has always been one of the national agendas especially in the developing countries where there exist a large proportion of young population. A study by Khazanah Research Institute (KRI) in August 2015 revealed that majority of young Malaysians cannot afford to have a roof over their heads even after many years in the labour force. The study also cited one of the reasons of unaffordability is due to that escalating price of new housing unit that outweighs the speed of salary increment (Ismail, Jalil, and Muzafar, 2015).

Based on the "median multiple" methodology, a house is considered affordable if the median house price does not exceed three times the median gross annual household income. The median multiple affordability (MMA) ratio, also known as the house-price-to-income ratio, has been used by the United Nations Centre for Human Settlement (UNCHS) and the World Bank under the Housing Indicators Program since 1998. As per the study conducted in 2012, the median of all house price was RM239,397, implying a multiple of 5.5 times against median gross income of RM43,512. This MMA ratio clearly exceeded the affordability benchmark of three (Cagamas Berhad, 2013).

Moreover, as shown in Figure 1, the Malaysian House Price Index (MHPI) has accelerated from 2009 to 2015 with a compound annual growth rate of 9.6 percent. Prior to 2009, the index has grown around 3.2 percent per year from 2001 to 2009. [1]



Source: National Property Information Centre (2015)

Figure 1 Annual change of Malaysian Housing Property Index (MHPI) (%)

Housing is a basic need enshrined under the United Nation's Sustainable Development Goals (UNDP). [2] Hence, the challenge of providing affordable housing has become a major task of policymakers around the world. From 2012, the housing provision system in Malaysia has mostly focused on improving the affordability of housing (Shuid, 2016). Among the initiatives taken are the 1Malaysia People Housing (PR1MA) in 2011, the Private Affordable Ownership Housing Scheme (MyHome) in 2014 and the First Home Deposit Scheme (MyDeposit) in 2016. Nevertheless, the problem of housing affordability is still unresolved and often discussed in the mass media (Hamid, 2017; Yap and Ng, 2018).

Affordable housing price is a concern of many individuals and households. To many, buying a property for own stay could be the single and largest expenditure in a lifetime. Hence, the fluctuation in house price can also be considered as one type of financial risk to house buyers (Cocco, 2005; Glindro, Subhanij, Szeto, and Zhu, 2011; Yao and Zhang, 2005). However, it is no doubt that the speculative activity by some property investors has further driven up the house prices in the last few years (Ng, 2013; Kamal, Hassan and Osmadi, 2016; Mohd Razif, et al., 2017)

Apart from speculation, many scholars also examine the potential factors in explaining the acceleration of house prices in different countries. For Malaysian studies, several researchers have analysed the fundamental factors such as construction cost, income, population, stock price, bank credit, and interest rate (Glindro et al., 2011; Hon-Chung, 2008; Ibrahim and Law, 2014; Lean and Smyth, 2014; Ong, 2013; Tang and Tan, 2015). Nevertheless, no analysis has been done on the impact of supply-side factors on house prices. Indeed, variable such as housing supply is considered to be

[1] The MHPI, basically a Paasche index, is based on the hedonic approach to price measurement using multivariate regression analysis. For more details, please refer to the explanatory notes of the 2015 HPI (National Property Information Centre, 2015).
[2] See more on United-Nations (2015).

one of the key determinants in explaining the fluctuation in house prices (Dieci and Westerhoff, 2016; Grimes and Aitken, 2010; Malpezzi and Wachter, 2005).

The data of housing supply or existing housing stock can be obtained from National Property Information Centre (NAPIC). However, it is only available from 2002Q3. [3] Since the sample period used for this study starts from 2000Q1, the construction output which is the component of the gross domestic product (GDP) has been used as a proxy of the housing supply in Malaysia.

The primary objective of this study is to investigate the interaction between house prices, housing loans, construction output and interest rate. This study uses different categories of housing loan in examining the response of bank lending to a different range of house prices. The different categories of housing loan also reflect the income level and hence spending behaviour of the house buyers.

An autoregressive distributed lag (ARDL) framework is implemented, hence the *F*-bounds test for cointegration is applied to test the presence of long-run linkage among the variables. Both the short- and long-run impact will also be identified.

This study also fills the literature gap by using construction output as the proxy of the housing supply. In addition, this study also utilizes the aggregate and disaggregate dataset of various types of housing loan to examine the relationship between house prices and the selected macroeconomic variables.

The remainder of the paper is organized as follows. Section 2 reviews the literature, followed by data. Section 4 discusses the result and the last section concludes the study.

LITERATURE REVIEW

Studies on Residential Property Prices

Past studies like Hofmann (2001) has evaluated the linkage between bank lending, property prices, GDP, and real interest rate in 16 industrialized countries from 1980 to 1998. He finds that property prices are imperative for the long-term development of bank lending. Bank lending is positively cointegrated to property prices and GDP, but negatively related to the real interest rate. Furthermore, in analyzing the dynamic interaction, a significant two-way relationship is found between bank lending and property prices. He also points out the innovations to short-term real interest rate have a vigorous and adverse impact on bank loans, property prices and GDP.

By using a multivariate empirical framework, Hofmann (2003) and Goodhart et al. (2006) find a bidirectional relationship between credit and property prices, but the impact of property prices on credit is stronger than the other way around. In their study on the factors affecting house prices in Central and Eastern Europe (CEE), Égert and Mihaljek (2007) observe the robust relationship between house prices with both interest rate and housing loans respectively. Demographic factors and labour market development are also found to play a significant role in house price dynamics.

Also, Goodhart and Hofmann (2008) identify an important multi-dimensional link between bank lending, residential property prices, and the macroeconomy with a panel vector autoregressive (VAR) of 17 industrialized countries. The relation between bank lending and house prices is found in two-way. Moreover, the empirical result further shows that a large portion of money and credit shocks on house prices are stronger during periods of house price boom.

Establishing Tobin's *q* model, Carrington and Madsen (2011) suggest that house prices oscillate around their long-run equilibrium. It is because of the changes in credit availability, income and nominal interest rates in the Organisation for Economic Cooperation and Development (OECD) countries. House prices are associated with bank lending positively in short-run, but negatively in long-run. The empirical results also show that bank lending plays a fundamental role in driving house prices. Meanwhile, interest rate and income have only secondary effects on house prices fluctuation.

In examining the linkages in individual countries, Brissimis and Vlassopoulos (2009) find the existence of one cointegration which is interpreted as a mortgage loan equation. In other words, housing loans are determined by house prices, GDP, and interest rate. The house prices are found to be weakly exogenous. Although no long-run causality is

[3] The data of existing housing stock can be obtained from National Property Information Centre (NAPIC), http://napic.jpph.gov.my/portal/key-statistics

found from mortgage lending to house prices, they reveal the evidence of a contemporaneous bidirectional dependence in the short-run.

Fitzpatrick and McQuinn (2004) show that house prices and mortgage credit are mutually dependent in Ireland, for both short- and long-term. In the dynamic specification, they find that the contemporaneous effect only exists from credit to house prices. Similarly, examining the Irish property market, McQuinn and O'Reilly (2008) show that a long-run linkage exists between house prices and bank lending. They also reveal that some loans, in turn, depend on the disposable income and interest rate.

By using quarterly data from 1975 to 2006, Oikarinen (2009) highlights a two-way relation between house prices and household borrowing in Finland since the financial liberalization in the 1980s. The impact of house prices on the amount of housing loan is found only after the abolishment of the tight credit market control. Gimeno and Martínez-Carrascal (2010) investigate the linkages between housing loans and house prices in Spain. They find out the interdependence of both variables in the long-run.

With a structural vector equilibrium correction model (SVECM) over the period 1986 to 2008, Anundsen and Jansen (2013) establish a two-way long-run relation between house prices and credit in Norway. The empirical results suggest that the credit is useful for dynamics of house prices, but house prices only influence household borrowing through the equilibrium-correction term. They also highlight that the dynamic effect of house prices and bank lending are dampened to all shocks after augmenting a model of the supply side of the housing market.

Asian countries have experienced rapid growth in housing markets over the past decade, and have focused by numerous researchers. Collyns and Senhadji (2002) note that the development of credit has a simultaneous impact on house prices in Korea, Hong Kong, Singapore, and Thailand. The empirical results suggest that credit contributes significantly to property price inflation. The impact of property prices is stronger before the Asian crisis and during rising property price periods. Moreover, by running individual countries, the results from vector autoregressive (VAR) analysis suggest the bidirectional causality between bank lending and house prices for all countries except Thailand.

Zhu (2006) examines the structural characteristics and the behaviour of house prices in six Asian economies. The cointegration analysis reveals the presence of nexus between house prices in long-term among these economies and their economic factors. The various results obtained, suggesting that the determinants of house prices tend to be country-specific. Specifically, bank lending is a crucial driving factor in all economies except the countries with the least developed financing sector, which is Indonesia.

Gerlach and Peng (2005) analyze the cointegration among real bank lending, real property prices, and real GDP in Hong Kong from 1982 to 2001. They suggest a unidirectional causality, both short-run and long-run, from property prices to credit, implying bank credit is mainly demand-driven. With ARDL methodology, Liang and Cao (2007) concentrate on the property market in China over the period 1999 to 2006. The empirical analysis shows a unidirectional causality from bank lending to property prices, which works through the error correction term from bank credit. The causality also includes GDP and interest rate.

A separate study by Addae-Dapaah and Anh (2014) find the presence of a long-run linkage among house prices, bank credit, interest rate and GDP in Singapore. A long-run causality of bank lending is running positively to house prices and GDP, while negatively to the interest rate. However, the analysis shows no correlation between bank lending and house prices in the short-run, suggesting an immediate desired output may not be gained if aiming housing loans as a control for property price inflation in Singapore.

Inoguchi (2011) evaluates the impact of real estate prices on domestic bank lending in Malaysia, Singapore, and Thailand before and after the Asian financial crisis. The empirical analysis suggests the positive impact of real estate prices, which used as collateral, on bank lending after the crisis in Singapore and Thailand, but not in Malaysia. The regression analysis suggests that the interest rate spread affected bank lending in all three studied countries. These results support the view that the changed behaviour in bank lending after the crisis.

Ibrahim and Law (2014) focus on house price behaviour and their dynamic interactions with bank lending, real output and interest rate in Malaysia. More interestingly, they run the empirical framework at both aggregate and disaggregate house price levels. From the aggregate perspective, a positive long-run relation is noted from bank lending to house prices. Both residential property prices and bank lending adjust to the long-run equilibrium. Notably, the disaggregate analysis reveals that only terraced house price index is cointegrated with bank lending, real output, and interest rate. It tends to make an adjustment towards the long-run.

In evaluating the effect of housing loans on the house prices in Malaysia by using ARDL framework, Law and Lim (2016) show that the empirical results concur with the hypothesis that loan supply is associated positively with house prices. They also find out that subprime mortgage crisis brings to a decline in house prices in the long-run. This result suggests the policymakers monitor the behaviour of housing loans via monetary or macro-prudential policy in order to control house prices.

DATA

Quarterly data from 2000Q1 to 2016Q4m is used in this study. The quarterly data on Malaysian House Price Index (MHPI) are available from the year 1999 via the publication by the Valuation and Property Services Department in Malaysia. After examining the performance of residential property prices, sample period from 2000Q1 onwards is selected to exclude the period of the Asian Financial Crisis.

The response of bank lending is examined by using a number of loans granted for the purchase of residential property in both commercial banks and merchant banks. The series of housing loan is obtained from the Monthly Statistical Bulletin of Bank Negara Malaysia. [4] Apart from the aggregate housing loan, there are also six subgroups corresponding to various loan categories of residential property according to the data provided, which are:

- Low-cost houses (RM25,000 and below);
- Low-medium cost houses (RM25,001 – 60,000);
- Medium cost houses (RM60,001 – 100,000);
- High-medium cost houses (RM100,001 – RM150,000);
- High cost houses (RM150,001 – 250,000); and
- Higher cost houses (above RM250,000).

These sub-categories are considered alternatively in the analysis. Other data such as the gross domestic product of construction (GDPC), base lending rate (BLR), and consumer price index (CPI) are extracted from the Thomson Reuters Datastream. The base year of 2010 is applied for GDPC and CPI. MHPI and nominal housing loans are inflationary adjusted to obtain real house price and real housing loans, respectively. Real GDPC is used as a proxy for construction output. The real interest rate is the average lending rate (BLR) minus the inflation rate. Real loans and real GDPC are both given in RM million. Except for the base lending rate, the first seasonal adjustment is applied to all variables by the X12 procedure (Ibrahim and Law, 2014) and then expressed in natural logarithm.

Autoregressive Distributed Lag (ARDL) Approach

In exploring the long-run relationship among bank lending, residential property prices, construction output, and interest rate, there are numerous methods are available such as residual-based test by Engle and Granger (1987), and the maximum likelihood test by Johansen and Juselius (1990). In this study, the bounds testing approach is applied via an autoregressive distributed lag (ARDL) framework. This framework is introduced originally by Pesaran and Shin (1995) and further expanded by Pesaran, Shin, and Smith (2001).

There are several advantages of the ARDL approach. ARDL modelling is a particularly attractive approach when the variables are of the different order of integration. Hence, it can avoid the problems arising from non-stationary time series data. ARDL approach involves only a single-equation set-up, making it easy to apply and interpret. Moreover, the ARDL approach also applies ample numbers of lags to evaluate the behaviour of data using the framework of general-to-specific modelling (Laurenceson and Chai, 2003). This enables a different number of lags can be assigned to each variable.

Banerjee, Dolado, Galbraith, and Hendry (1993) also mention that a transformation of ARDL can form an error correction model (ECM), which enables short- and long-run impact to be estimated simultaneously (Dritsakis, 2011). The bounds test approach also has better small sample properties (Narayan and Smyth, 2005) than another popular cointegration method. The selected lag orders in an ARDL model is based on information criterion.

An ARDL (*p*,*q*,*r*,*s*) model may be written as:

$$\ln mhpi_t = \mu + \sum_{i=1}^{p} \alpha_i \ln mhpi_{t-i} + \sum_{j=0}^{q} \beta_j \ln loan_{t-j} + \sum_{k=0}^{r} \gamma_k \ln gdpc_{t-k} + \sum_{l=0}^{s} \delta_l blr_{t-l} + \varepsilon_t \tag{1}$$

[4] See more on Bank Negara Malaysia (2017).

where *mhpi* is residential property prices, *loan* is bank lending, *gdpc* is construction output and *blr* is the interest rate.

Based Pesaran et al. (2001), the ARDL model is also expressed in the form of unrestricted error correction model (UECM). The ARDL approach to cointegration involves investigating the following unrestricted error correction model, UECM:

$$\Delta \ln mhpi_t = \theta_0 + \theta_1 \ln mhpi_{t-1} + \theta_2 \ln loan_{t-1} + \theta_3 \ln gdpc_{t-1} + \theta_4 blr_{t-1} + \sum_{i=1}^{a} \alpha_i \Delta \ln mhpi_{t-i} + \sum_{j=0}^{b} \beta_j \Delta \ln loan_{t-j} + \sum_{k=0}^{c} \gamma_k \Delta \ln gdpc_{t-k} + \sum_{l=0}^{d} \delta_l \Delta blr_{t-l} + \varepsilon_t \qquad (2)$$

In the equation (2), Δ denotes the first difference operator, $\theta_1, \theta_2, \theta_3$ and θ_4 are the long-run coefficient, and ε_t is assumed to be white noise errors. The *F*-test is applied to examine the presence of cointegration between the variables by examining the significance of the variables with lagged levels. The null hypothesis of the *F*-test is

$$H_0 : \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0,$$

which is equivalent to the absence of long-run relationships in the model.

The ARDL approach evaluates $(p+1)^k$ of regressions to acquire the optimal lags of each variable, where *k* denotes the number of variables tested in the test equation, and *p* is the utmost number of lags applied in each variable (Shrestha and Chowdhury, 2005). Since quarterly data is used, four lags are selected as the maximum lags for model selection criteria. The Akaike Information Criterion (AIC) is used to select the optimal lag structure as to avoid the issue of underestimation.

Two asymptotic critical value bounds are used, with upper bound represented by the critical values for *I*(1) series, while lower bound indicated by the critical values for *I*(0) series. The null hypothesis of the absence cointegration can be rejected if the test statistics fall above the upper bound. Alternatively, the null hypothesis is accepted if the test statistics is under the lower bound. However, when the *F*-statistics lies between these two bounds, the inconclusive inference would be made. Referring to Pesaran et al. (2001), the asymptotic critical value bounds for this study refer to *F*-statistics where the number of regressors is three. Table *CI* of cases *III* and *V* are used for cases which have unrestricted intercept and no trend, and unrestricted intercept and unrestricted trend, respectively.

An ARDL model can be transformed into a long-run form, showing the long-run elasticity of the dependent variable to an adjustment in the independent variables. If the conclusion of the existence of cointegration is made, the long-run coefficients can be calculated. From Equation (4), the long-run coefficients for housing loan, construction output, and base lending rate are $-(\theta_2/\theta_1)$, $-(\theta_3/\theta_1)$, and $-(\theta_4/\theta_1)$, respectively.

An error correction model (ECM) is evaluated to measure the speed of adjustment towards equilibrium:

$$\Delta \ln mhpi_t = \pi_0 + \sum_{i=1}^{a} \pi_{1i} \Delta \ln mhpi_{t-i} + \sum_{j=0}^{b} \pi_{2j} \Delta \ln loan_{t-j} + \sum_{k=0}^{c} \pi_{3k} \Delta \ln gdpc_{t-k} + \sum_{l=0}^{d} \pi_{4l} \Delta blr_{t-l} + \pi_5 ecm_{t-1} + \varepsilon_t \qquad (3)$$

Deviations from equilibrium are shown as:

$$ecm_t = mhpi_t - \beta_1 loan_t - \beta_2 gdpc_t - \beta_3 blr_t \qquad (4)$$

If the equilibrium is found in the variables, the error correction term, ecm_t is zero; whereas deviation from equilibrium is displayed in a non-zero error term. The short-run impact was expressed by the total coefficients of the differenced variables in Equation (4).

RESULTS AND DISCUSSION

ARDL Model Estimation and Cointegration

A mixture of integration order, I(0) and I(1) processes, suggests the approach of autoregressive distributed lag (ARDL) would be suitable for the study[5]. The analysis on residential property prices is conducted by using the Malaysian House Price Index (MHPI) as a proxy. The effect of various loan categories is considered by estimating the specific model for different categories of housing loans. First and foremost, the ARDL bounds test is conducted to verify the presence of the long-run nexus between the variables in the model. By using AIC, the optimal lag length is determined. The results of the bounds *F*-test for all the residential property models are presented in Table 1.

Since the computed *F*-statistics exceed the upper bound of critical values for all loan categories, the empirical findings imply that all the house price models have at least one long-run relationship between the variables investigated, which are house prices, housing loan, construction output, and interest rate. The assumption of normality and homoscedasticity are satisfied in all models. The diagnostic checking is conducted to ensure the adequacy of models.

Table 1 Bounds F-Test for cointegration – Residential property price equation

Model	Loan Categories	ARDL Model	F-statistics*	Case	Conclusion
1	Total Loan	ARDL (1,0,1,4)	10.426***	III	Cointegration
2	Loan for Low Cost	ARDL (1,0,0,1)	8.129***	III	Cointegration
3	Loan for Low-Medium Cost	ARDL (1,0,0,1)	9.170***	III	Cointegration
4	Loan for Medium Cost	ARDL (1,0,0,1)	8.727***	III	Cointegration
5	Loan for High-Medium Cost	ARDL (1,0,0,4)	11.386***	III	Cointegration
6	Loan for High Cost	ARDL (1,0,0,4)	12.123***	III	Cointegration
7	Loan for Higher Cost	ARDL (1,0,0,4)	10.623***	III	Cointegration

****, **, and * denote 1%, 5%, and 10% significance level, respectively. The lag orders are selected using AIC. The relevant critical value bounds are given in Table CI (iii) and (v) for F-statistics (number of regressors = 3) in Pesaran, Shin, and Smith (2001), where Case III is with unrestricted intercept and without trend; Case V is with unrestricted intercept and unrestricted trend.*

Since preliminary inspection of the relationship between MHPI and all variables investigated, the existence of causality is inspected. The long-run elasticities on house prices reported in Table 2 are found to have a close anticipation.

Looking at the aggregate data, the highly significant and positive elasticities towards house prices are found from housing loan, construction output, and interest rate. An increase in housing loan, construction output, and interest rate will raise the house prices, respectively. A 10 percent increase in housing loans is significantly related to an increase of 2.7 percent in house prices. Meanwhile, a 10 percent increase in construction output raise the house prices by 2.7% percent the long-run. The interest rate, as a predominately variable, has a relatively low long-run impact on house prices. A 10% increase in interest rate will only lead to a 0.6 percent increase in house prices.

Table 2 Long-run elasticities on residential property prices

Loan Categories	Dependent Variable	Housing Loan	GDPC	BLR
Total Loan	**MHPI**	0.269***	0.269***	0.061**
Loan for Low Cost	**MHPI**	-0.071	0.554***	0.017
Loan for Low-Medium Cost	**MHPI**	0.147*	0.727***	0.014
Loan for Medium Cost	**MHPI**	0.162*	0.701***	0.013
Loan for High-Medium Cost	**MHPI**	0.284***	0.441***	0.032***
Loan for High Cost	**MHPI**	0.219***	0.503***	0.050**
Loan for Higher Cost	**MHPI**	0.132***	0.298***	0.051**

Note: ****, **, and * denote 1%, 5%, and 10% significance level, respectively.*

From the perspective using disaggregate data, the long-run elasticity of construction output with respect to house prices in all models are found to be highly significant and positive, implying that an increase in housing supply will

[5] Both ADF and PP tests come to an agreement that all variables are non-stationary except the variables base lending rate, loans granted for total, low-medium cost, medium cost and high-medium cost houses. See Appendix A for more details.

* The lower and upper limits for F-statistics in Case III are 4.29 and 5.61 for 1%, 3.23 and 4.35 for 5% and 2.72 and 3.77 for 10%; in Case V, the lower and upper bound for F-statistics are 5.17 and 6.36 for 1%, 4.01 and 5.07 for 5%, and 3.47 and 4.45 for 10%.

lead to an increase in house prices. This might be driven by the wealth position of homeowners and housing affordability (Mayer and Somerville, 2000). Notably, a high proportion in long-run elasticities of construction output is found towards house prices in models of low-ended housing loans. The situation is reasonable as there is still a strong demand and opportunities for affordable properties. [6]

In recent years, developers are attracted to the construction of higher-end properties priced above half a million Ringgit in Malaysia. Consequently, a serious mismatch is found in the Malaysian housing market in terms of what is offered by developers and what is affordable for buyers to purchase.[7] Affordable housing projects should be encouraged for the developers, to meet the demand for homebuyers, especially first-time buyers. Increases in housing loans have a positive effect on house prices except for the model of low housing loan, which shows an insignificant negative impact. Higher credit availability can increase housing demand if households are borrowing constrained, which will then increase house prices. Moreover, house prices may increase due to the higher expected returns on housing. (Hofmann, 2003).

However, a low proportion of long-run elasticities of the real interest rate is found to be significantly positive towards house prices. This contradicts with the expected negative relation. Changes in interest rate can be reflected by the removal of interest rate restriction and it can be positively associated with the availability of bank lending. Although a low proportion of increment in house prices reacts to a rise in interest rate, the monetary authority has to be cautious of their policy actions as well.

Interestingly, the long-run impacts of housing loan and interest rate towards house prices seem to be affected by the co-movements between loans of high-end housing (RM100,000 and above). This might be due to the close linkages between housing loan and interest rate, which they are both highly significant towards house prices in models of high-end housing. The increase in interest rate can be said to influence the housing loans for high-end housing, which will then lead to a rise in house prices. Although the causality might not be true, this can be guidelines to policymakers for further action in reviewing housing policy.

After analyzing the long-run impact in the housing market, a frequent inquiry would be how long the housing market will take to return to equilibrium after an exogenous shock to the economy. Table 3 shows the error correction models on house prices with respect to different loan categories.

Table 3 Error correction model for the adjustment process of house prices

Loan Categories	***Dependent Variables***	**Housing Loan**	**GDPC**	**BLR**	**ECT_{t-1}**
Total Loan	**MHPI**	0.031***	0.103**	0.004***	-0.114***
Low cost	**MHPI**	-0.006	0.047***	0.004***	-0.084***
Low-medium cost	**MHPI**	0.014**	0.070***	0.003***	-0.096***
Medium cost	**MHPI**	0.016**	0.068***	0.003***	-0.097***
High-medium cost	**MHPI**	0.041***	0.064***	0.003**	-0.144***
High cost	**MHPI**	0.025***	0.056***	0.004***	-0.112***
Higher cost	**MHPI**	0.015***	0.033**	0.004***	-0.111***

****, **, and * denote 1%, 5%, and 10% significance level, respectively.*

The error correction term (ECT) of all models has the correct sign and is highly significant. For instance, ECT of -0.114 in aggregate loan model indicates that about 9 quarters or two years is required for full adjustment of house prices after an exogenous shock. The empirical results of disaggregate data show that house prices for low-end housing loans take a longer period to return to equilibrium following a shock than house prices for high-end housing loans.

For models of low-end housing loans, the house prices correct its previous period disequilibrium at a speed of 8 to 10 percent quarterly to reach the steady state. On the other hand, for models of high-end housing loans, the speed of adjustment for house prices are in the range of 11 to 15 percent quarterly to achieve the equilibrium. The speed of adjustment of house prices across loan categories should be taken into account when designing policies for housing loans. More attention should be focused on the low-end houses as its slower adjustment to equilibrium after an exogenous shock.

[6] The view is revealed by Director General of Valuation and Property Services Department Dr. Rahah Ismail at the 10th Malaysian Property Summit 2017 (Khoo, 2017).
[7] National House Buyers Association (HBA) Honorary Secretary-General Chang Kim Loong has expressed his opinion in an email to The Edge Financial Daily (Surendram, 2016).

The aggregate data show that the housing loan, construction output, and interest rate have a significant and positive short-term impact on house prices, respectively. Within four quarters, an increase in housing loan, construction output, and interest rate can lead to an upturn in house prices, respectively.

In studying the short-term elasticities of housing loans towards house prices, disaggregate data show there is a significant and positive impact on house prices expect the loan for low-cost housing, which presents an insignificant negative impact. The significant positive impact suggests that a larger amount of housing loans reflects the strong housing demand in Malaysia. This situation will then lead to a higher priced residential property. The phenomenon of strong housing demand most probably occurs in houses cost RM100,000 and above.

A significant and positive impact on construction output is found towards house prices for all models, implying the sensitivity of house prices towards supply-side factor in the short-run. An 80 percent rise in the residential overhang value from RM4.6 billion in 2015Q3 to RM8.27 billion in 2016Q3(Khoo, 2017)

Nevertheless, the housing supply is still positively associated with house prices. This might because of the rapid growth of population and the strong demand for residential property in Malaysia. With more than 70 percent of the population below the age of 40s (Department of Statistics, 2016), the demand for houses always exceeds the supply (Mahalingam, 2018).

On top of that, the interest rate is also found to have a significant positive short-run impact on house price, for all the models across loan categories. Similar to the long-run elasticities, this opposes with the expected negative relation. Otwoma (2013) proposes that when there is a low-interest rate, any growth in interest rates will increase the housing demand. This is because homebuyers rush to lock in low-interest rate with the expectation that interest rate will rise further, hence increasing house prices. Although the scenario has not been proven to be applicable in the case of Malaysia, this psychological factor should be one of the considerations in policy reviewing in Malaysia. This analysis results can provide useful input for the authorities in the development of housing policies such as allowing a fixed rate loan for the first few years.

CONCLUSION

This paper empirically examines the linkages between residential property prices, bank lending, construction output, and interest rate in Malaysia. The cointegration analysis of the house price models estimated across seven loan categories indicates that house prices have a long-run equilibrium relationship with bank lending, construction output, and interest rate. This implies the ability of house prices to converge to the long-run equilibrium after an exogenous shock.

Focusing on the aggregate data, bank lending, construction output, and interest rate have positive elasticities towards house prices, in both short- and long-term. The highly significant impact ensures a close relationship between house prices, and bank lending, construction output, and interest rate. Error correction term of -0.114 in aggregate loan model indicates that about eight quarters or two years is required for full adjustment of house prices after experiencing a shock.

Further analysis across different loan categories captures a detailed insight into the relationship between house prices and regressors. The elasticities of house prices against construction output are found in all models across loan categories, regardless of the time period. This implies the sensitivity of house prices towards supply-side factor in both short- and long-run.

Notably, models of low-end housing loans (RM100,000 and below) show there is a relatively high and long-run impact of construction output towards house prices, compared to high-end housing loan models. The situation is reasonable as there is still a strong demand and opportunities for affordable properties.

According to BNM in its Annual Report 2016, the house prices up to RM165,060 are still considered affordable to a median Malaysian household. With a higher density of development, developers can produce more affordable housing via the economies of scale. In fact, developers have been concentrating on affordable housing in the last two years. It will take some time for the issue of affordability to be resolved.

Higher bank lending (beyond RM100,000) is found to be positively associated with house prices, in long-term. If households are borrowing constrained, higher credit availability can increase housing demand. This will lead to an increase in house prices. The scenario is in line with our view whereby individuals who purchase high-end housing will still be borrowing.

On top of that, the interest rate has a significantly positive short- and long-run elasticities on house prices, across seven models of loan categories, which is contradicted with the expected negative linkages. When the interest rate is low, any of its growth will increase the housing demand. This is because homebuyers rush to lock in low interest rates as they expect that the interest rate will rise further in the future, hence increasing house prices.

Although there is a low proportion of increment in house prices with respect to interest rate, the monetary authorities have to be cautious in their policy actions as its impact exist in both short- and long-run. The empirical results of disaggregate data further show that house prices for low-end housing loans take a longer period to return to equilibrium following a shock than house prices for high-end housing loans. This is a suggestion for policymakers to consider the speed of adjustment of house prices across loan categories in making housing policies.

Further research can be done by using data from regions in Malaysia due to different patterns of housing demand and supply. For example, more developed states like Penang, Selangor and Johor which face more rural to urban migration as compared to other states like Sabah and Sarawak. Such analysis will provide better insight into the underlying structure of housing market in different economic corridors. The insight from construction output on regional house prices using regional or state-level house prices could be a good extension to the present study.

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ACKNOWLEDGEMENT

The authors would like to acknowledge the useful comment from the discussants and participants of the 4th Annual Bank NegaraMalaysia Economics Research Workshop, “The Housing Market: Issues and Policy Options” held on 10 October 2016, Sasana Kijang, Bank Negara Malaysia, Kuala Lumpur.

APPENDIX A:

ADF and PP unit root test

	ADF		PP		
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	
Level					
ln MHPI	-0.533 (10)	-2.194 (10)	2.001 (4)	-0.794 (4)	
ln GDPC	1.282 (1)	-1.462 (0)	1.767 (3)	-1.459 (2)	
BLR	-1.980 (8)	-1.756 (8)	-3.634 (1)***	-3.599 (1)***	
ln Total	-2.601 (2)*	-1.528 (6)	-3.065 (3)**	-3.442 (1)*	
ln Low	-1.487 (0)	-2.715 (1)	-1.559 (2)	-1.927 (0)	
ln LM	-0.022 (0)	-4.025 (0)**	-0.810 (5)	-4.259 (3)***	
ln Medium	1.734 (6)	-4.669 (0)***	-1.379 (5)	-5.769 (5)***	
ln HM	-4.495 (0)***	-2.754 (0)	-4.495 (0)***	-2.754 (0)	
ln High	-4.295 (2)***	-1.679 (0)	-5.555 (1)***	-1.739 (4)	
ln Higher	-2.527 (1)	-2.471 (0)	-2.742 (3)*	-2.320 (2)	
First Differencing					
ln MHPI	-1.478 (8)	-5.874 (0)***	-5.209 (4)***	-5.987 (3)***	I(1)
ln GDPC	-5.685 (0)***	-6.273 (0)***	-5.755 (3)***	-6.255 (1)***	I(1)
BLR	-6.018 (7)***	-6.139 (7)***			I(0)
ln Total		-7.659 (5)***			I(0)
ln Low	-7.266 (0)***	-7.231 (0)***	-7.256 (3)***	-7.220 (3)***	I(1)
ln LM	-2.429 (2)		-5.473 (4)***		I(0)
ln Medium	-8.873 (5)***		-5.303 (4)***		I(0)
ln HM		-7.580 (0)***		-7.609 (2)***	I(0)
ln High		-5.208 (1)***		-8.207 (1)***	I(1)
ln Higher	-10.388 (0)***	-11.037 (0)***		-10.785 (3)***	I(1)

The asterisks ***, ** and * denote 1%, 5% and 10% significance level, respectively.
Figure in the parentheses represents optimal lag length chosen using AIC for the ADF test, and Newey-West bandwidth with Bartlett kernel estimation for PP test. Both constant and linear trend terms are included in the test equations.

Appendix B:
Diagnostic checking for ARDL model

Model	R^2	F	Serial Correlation	Normality	Heteroscedasticity	CUSUM	CUSUMSQ
1	0.9982	3352.645***	CHSQ(4): 0.4816 (0.9753)	0.5260 (0.7687)	CHSQ(9): 4.4217 (0.8815)	stable	stable
2	0.9976	5162.567***	CHSQ(4): 6.3336 (0.1756)	0.5180 (0.7718)	CHSQ(5): 4.6926 (0.4545)	stable	stable
3	0.9977	5398.322***	CHSQ(4): 2.9427 (0.5675)	0.9065 (0.6356)	CHSQ(5): 6.4370 (0.2660)	stable	stable
4	0.9977	5333.293***	CHSQ(4): 3.5728 (0.4669)	0.8646 (0.6490)	CHSQ(5): 5.6422 (0.3426)	stable	stable
5	0.9984	4270.269***	CHSQ(4): 2.1789 (0.7029)	1.5298 (0.4654)	CHSQ(8): 5.2785 (0.7274)	stable	stable
6	0.9982	3900.187***	CHSQ(4): 0.5344 (0.9701)	1.0042 (0.6053)	CHSQ(8): 5.1214 (0.7445)	stable	stable
7	0.9981	3577.967***	CHSQ(4): 2.9299 (0.5696)	1.0014 (0.6061)	CHSQ(8): 3.5733 (0.8934)	stable	stable

***, **, and * denote 1%, 5%, and 10% significance level, respectively. F denotes F-statistics while CHSQ denotes Chi-square statistics. Meanwhile, p-values are presented in the parentheses.