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A NONLINEAR ARDL ANALYSIS ON THE RELATION BETWEEN HOUSING PRICE AND INTEREST RATE: THE CASE OF MALAYSIA

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Abstract*: The purpose of this study is to examine the effect of interest rate on housing price index in Malaysia. A nonlinear Autoregressive Distributed Lags (NARDL) model has been applied for the period 1980Q1-1998Q1 and 1998Q2-2017Q1 to uncover the short run and long run effect of interest rate on Malaysia's housing price index. Throughout the period of 1980Q1-1998Q1, the model of NARDL estimation indicated a significant long run positive relationship of interest rate increases to housing price index, and an insignificant long run negative relationship of interest rate decreases to housing price index. For the period of 1998Q2-2017Q1, the interest rate increases and the interest rate decreases are insignificant to influence the housing price index. This suggests that the role plays by the interest rate to explain the movement towards the housing price index in Malaysia is getting less influence than before.*

Keywords: *Housing Price Index; Money Market Rate; Gross Domestic Product (GDP); Consumer Price Index; Nonlinear Autoregressive Distributed Lag (NARDL)*

Introduction

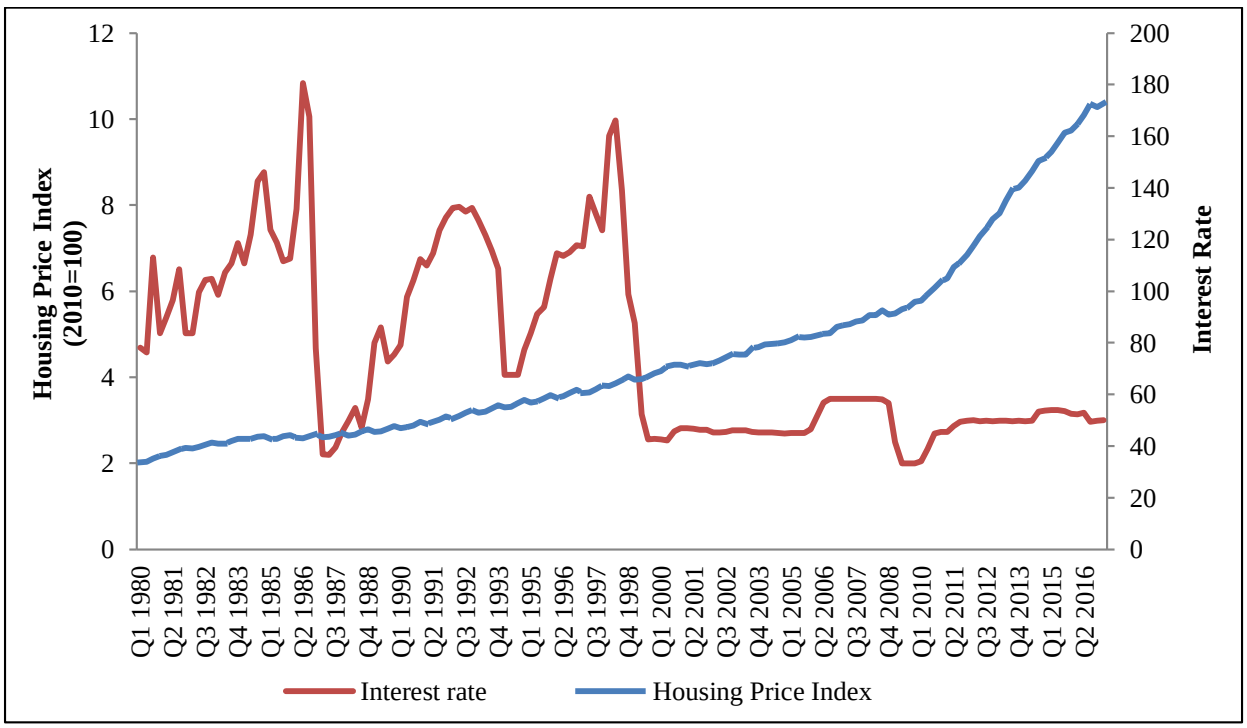
The news of high prices and oversupply of the properties spread on the social media in Malaysia recently. After the news released, it puts the pressure on the owner, developer, investor and the government. Many of the researchers in Malaysia warned that the problem will be get worse in year 2018. Anyway, what makes this happen? Bank Negara Malaysia (BNM) had unpredictability reduced the overnight policy rate (OPR) by 25 basis points in year 2016, it reduced the cost of the borrowing for the consumers and companies to take cheaper loan and purchase the properties. As a result, the housing prices were still growing.

Over the past three decades, housing price index (HPI) increases unstoppably until today and we believe it will continue growing in the next 5 years (See Figure 1). In previous studies,

majority of the researchers found a negative finding between the interest rate and housing price (Levin & Pryce, 2009 and Olanipekun & Adegoke, 2015). In the case of Malaysia, interest rate decreased sharply by 40% in 1st quarter 1986 and 38% in 1st quarter 1998 respectively, however, the housing price index at that period did not adjust much. In contrast, a small reduced by 2.8% of interest rate in year 2008, made the housing price index bid up by 3% compared to previous year. This strange phenomenon makes us curious about price adjustment from interest rate. If the decreased in the interest rate will cause the housing price increase, did changes in interest rate caused housing prices respond symmetrically or asymmetrically?

Most of the empirical evidence indicates that interest rate increases would reduce the housing prices. In response to a shock to the interest rate, housing prices show an exaggerated decline in an economy (Brady, 2011). Besides, Kim and Min (2011) found evidence of the existence of housing price bubbles decreased with interest rate in Korea. In addition, Ligita, Rita and Arjan (2016) indicated that interest rate and availability of bank loans were established as the factors that have the most significant impact on housing price level. In the environment of low interest rates, foreign demands have continuously flooded into many economies, persistently pushing up the housing price (Tai *et al.*, 2017). On the other hand, Song, Jou and Tripe (2014) found that increase in interest rate may not be effective in reducing the real housing prices as interest rate positively and significantly affects the real housing prices.

Figure 1: Housing Price Index and Interest Rate in Malaysia from 1980Q1 to 2017Q1



Source: Bank Negara Malaysia, 2017

Most research to date has focused on estimating the relationship between housing price and interest rate symmetrically as mentioned above. Most importantly, the non-linear impact of interest rate on housing price in Malaysia has not been thoroughly studied. This paper examines the asymmetric relationship between housing price and interest rate using nonlinear ARDL approach.

Literature Review

There has significant amount of study has focused on examining the relation between housing prices and household income for various countries. These studies not only looking at their relations in one direction but also examining their causal interactions by employing different methods. These include Chen *et al.* (2007) used a co-integration and VECM approach to analysis for the long-run relationship between house prices and income levels in Taiwan. The results showed that slow surge in income may just sustain the long run trend in housing prices. The deviation between housing prices and income were caused by money supply. Holly *et al.* (2010) applied the panel-data approach to examine the relationship between housing prices and income in the U.S and they found positive relationship between real housing prices and income. Moreover, Apergis *et al.* (2015) found a bidirectional relationship between housing prices and real income per capita for short and long run horizons in 351 U.S metropolitan. According to Chen and Patel (1998), Gallin (2006), McQuinn and O'Reilly (2008), Holmes and Grimes (2008), Kim and Bhattacharya (2009) and Abbott and De Vita (2012 & 2013) have examined short run causality or long run relationship between housing prices and income or included some other variables in different countries. Mohsen and Seyed (2017) found that household income changes have asymmetric effects on housing prices in most of the states in U.S whereby 18 states have short run impact asymmetry and 21 states have significant long run asymmetry by using nonlinear ARDL modelling method.

While the above studies examined the relation between housing prices and household income for several countries. However, some of the studies focus on the link between housing prices and interest rates for different countries. McQuinn and O'Reilly (2008), Ibrahim and Law (2014), and Tang and Tan (2015) showed a negative relationship between interest rates and housing prices in long-term. Coşkun (2015) found that real interest rate has a substantial influence on the demand for housing in Turkey. Besides that, Panagiotidis and Printzis (2015) proven that the relationship between interest rates and housing prices varies in the short run as compared with long run. In conventional economic theory, the relationship between interest rates and housing prices should be negative relationship, but several researches have found an opposite relationship. For instance, Öztürk and Fitöz (2009) found a positive relationship between housing prices and interest rates in Turkey. Tak et al. (2003) found that there has a significant difference between the effect of interest rate on housing prices in Hong Kong whereby interest rate and housing prices have positive relationship in inflationary pre-1997 period and negative relationship in deflationary post- 1997 period. According to Tse (1996a), he recommended that the housing prices and real interest rate have negative relationship. Besides that, Tse (1996b) suggested that the intense rise in housing prices in 1991 was due to an expectation of increasing inflation coupled with declining interest rates in Hong Kong. Furthermore, Tse (1996c) concluded that the interest rate had direct effect on housing prices through the connected with exchange rate system in Hong Kong from 1984 to 1994. On the other hand, Tang and Tan (2015) illustrated that a decreasing real interest rate tends to increase housing prices in Kuala Lumpur but not applicable for others five states in Peninsular Malaysia by using quarterly data from 2001 to 2013. This study also found that there has one-way causation from the direction of real interest rate to real Malaysia House Price Indexes.

On the other hand, some of the studies focus the effects of inflation on housing prices. Katrakilidis and Trachanas (2012) examined the asymmetric impact of income and inflation on housing prices in Greek and the outcomes indicated that positive changes in consumer prices have a smaller impact on house prices than negative changes, whereas house prices respond more quickly to an increasing inflation rate than to a falling inflation rate in the short

run. Zhu (2004) showed the strong and long-lasting link between inflation as well as housing price. Geok and Hooi (2016) found that house prices respond to both energy and consumer prices symmetrically in the long-run for aggregate and four major types of houses while asymmetrically in the short-run. Grimes *et al.* (2004) also found that house prices adjustment response asymmetrically to consumer price changes.

Some studies have also included other control variables to evaluate the relationship on housing prices. For instance, the explanatory variables are interest rates, inflation, housing credit, money supply, construction costs, employment, stock market index and economic activity. Égert and Mihaljek (2007) studied the housing prices in 8 Central and Eastern European (CEE) and 19 OECD countries by employing panel DOLS methods. This study found that GDP per capita and housing prices have robust positive relationship whereas housing prices and real interest rates have strong relationship in both OECD and CEE countries. Housing prices tend to increase double as fast for a corresponding decline in real interest rates in CEE compared to housing prices in OECD countries. Adams and Füss (2010) examined the short and long-term dynamics of economic activity, construction costs and long-term interest rates on housing prices in 15 countries by employing panel cointegration techniques. Based on the results, an increase in long-term interest rates has a negative effect on housing prices while construction costs and economic activity have a positive effect. On the other hand, Apergis and Rezitis (2003) examined the impacts of certain macroeconomic factors on housing prices in Greece by using error correction vector autoregressive (ECVAR) model. The macroeconomic factors involved are money supply, employment, inflation and the mortgage interest rate. They found that all the variables under consideration affect housing prices especially the mortgage interest rate having the biggest explanatory power by employing variance decomposition analysis. Finally, Brissimis and Vlassopoulos (2008) studied the association between housing prices and mortgage lending. The results suggested that there has a bi-directional dependence in the short-run whereas the causation run from mortgage lending rate to house prices in the long-run does not applicable for this study.

Methodology

Most of the existing literature on housing prices is predominantly in a linear framework, and an important question that has not been addressed is whether housing prices exhibit nonlinearity. The Nonlinear ARDL cointegration approach (NARDL) is as asymmetric extension to the ARDL to capture both long-run and short-run asymmetries in a variable of interest. We adopt this modelling approach for our purpose. Following Schorderet (2003) and Shin *et.al.* (2011), we specify the following asymmetric long-run equation of housing price:

$$\ln HP_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln CPI_t + \alpha_3 MMR_t^+ + \alpha_4 MMR_t^- + e_t \quad (1)$$

where HPt is housing price, Yt is real GDP to capture the aggregate demand, CPIt is consumer price index and MMR_t is money market rate which is used to proxy interest rate. $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ are long run parameters to be estimated and it is white-noise error term.

The α_1 indicates the income elasticity of housing prices which expected to be positive sign. The higher the GDP will lead to the increase in housing prices. The α_2 indicates the price

elasticity of housing prices which expected to be positive sign. This means the CPI expansion (contraction) would lead to increase (decrease) in housing prices. The relation between the housing price and interest rate increase is α_3 which is expected to be negative. And the α_4 captures the long run relation between housing price and interest rate decrease. Since they are expected to move in the same direction, is α_4 expected to be negative. The MMR_t^+ and MMR_t^- represent the partial sums of positive and negative changes in MMR_t which can be derived as follow:

$$MMR_t^+ = \sum_{i=1}^{t} \Delta MMR_t^+ = \sum_{i=1}^{t} \max\left(\Delta MMR_i, 0\right)$$

(2)

and

$$MMR_t^- = \sum_{i=1}^{t} \Delta MMR_t^- = \sum_{i=1}^{t} \min\left(\Delta MMR_i, 0\right)$$

(3)

As discussed previously, the impact of interest rate on housing price may be asymmetric. This hypothesis can be tested by evaluating α_3 and α_4 in (1) as it captures the effect of positive and negative change in interest rate on housing price, respectively. There is no asymmetry found between interest rate and housing price if $\alpha_3 = \alpha_4$, however if $\alpha_3 \neq \alpha_4$ then it concluded the presence of nonlinear relation. Thus, equation (1) reflects asymmetric long-run interest rate pass through to the housing price.

Rewrite the equation (1) to an ARDL setting based on the Pesaran and Shin (1999) and Pesaran *et. al.* (2001), the below equation can be specified:

$$\Delta \ln HP_t = \alpha + \beta_0 \ln HP_{t-1} + \beta_1 \ln Y_{t-1} + \beta_2 \ln CPI_{t-1} + \beta_3 MMR_t^+ + \beta_4 MMR_t^- + \sum_{i=1}^{p} \phi_i \Delta \ln HP_{t-i}$$
$$+ \sum_{i=0}^{q} \gamma_i \Delta \ln Y_{t-i} + \sum_{i=0}^{q} \gamma_i \Delta \ln CPI_{t-i} + \sum_{i=0}^{s} \left(\theta_i^+ \Delta MMR_{t-i}^+ + \theta_i^- \Delta MMR_{t-i}^-\right) + u_t$$

(4)

The long run impacts of interest rate increase and interest rate reduction on the housing price are represented by $\alpha_3 = -\beta_3/\beta_0$ and $\alpha_4 = -\beta_4/\beta_0$, respectively. On the other hand, $\sum_{i=0}^{s} \theta_i^+$ measures the short-run influences of interest rate increases on housing price while $\sum_{i=0}^{s} \theta_i^-$ measures the short-run influences of interest rate decreases on housing price. Hence, in addition to the asymmetric long run relation, the asymmetric short-run influences of interest rate change on housing price are also captured in equation (4).

Data and Empirical Result

From the Figure 1, one can comment that there might be a structural break in these series. By using the Chow breakpoint test (Chow, 1960), the results suggest that the structural break point

occurred at the first quarter of 1998q1. Therefore, we divided the data into 2 separate periods 1980Q1-1998q1 (pre-crisis) and 1998q2 to 2017q1 (post-crisis) to effectively capture the effects on housing price. We consider housing price index (HPI) as a proxy of housing price with based 2010, Consumer Price Index (CPI) of the proxy of price level with based in year 2010, real Gross Domestic Product (Y) as a proxy of economics growth and money market rate (MMR) as a proxy of interest rate in our model. All the data are collected from the IMF's International Financial Statistics. All data are transformed into natural logarithm series prior the analysis except MMR.

Unit Root Test

NARDL approach does not require the variable to have the same order of integration which means the cointegration is applicable irrespective of whether the variables are I (0) or I (1), however the presence of I (2) variables will the computed F-Statistic for testing cointegration invalid. Given that bound test procedure cannot include I (2) variables, ADF and PP unit root tests are used to determine the stationary of the variables. The results are reported in Table 1.

Table 1: ADF And PP Unit Root Tests

	Level		**First difference**	
	Intercept and trend		**Intercept and trend**	
Variable	**ADF**	**PP**	**ADF**	**PP**
1980Q1-1998Q1				
LHPI	-3.734(12) *	-3.528(22) *	-3.799(4) **	-8.562(27) ***
LY	-2.365(0)	-1.928(3)	-5.485(0) ***	-5.482(1) ***
LCPI	-2.218(0)	-2.355(4)	-5.923(0) ***	-6.063(2) ***
MMR	-2.222(2)	-2.518(4)	-6.924(1) ***	-6.139(17) ***
1998Q2-2017Q1				
LHPI	-0.509(0)	-0.56(2)	-7.845(0) ***	-7.839(1) ***
LY	-3.096(2)	-1.781(0)	-5.923(2) ***	-4.772(5) ***
LCPI	-2.773(1)	-2.231(4)	-7.316(0) ***	-7.419(11) ***
MMR	-10.494(1) ***	-5.431(3) ***	-5.321(0) ***	-5.839(5) ***

Note: the numbers in parentheses are the lag order in the ADF test. The lag parameters are selected based on the SIC. Truncation lags are used for the Newey–West correction of the PP test in parentheses. ***, **, * indicates significance at the 1%, 5% and 10% level. Critical values are from Mackinnon (1991).

In the test we include both constant and trend terms and employ the SIC for the optimal lag order in the ADF test equation. In the first sample (1980Q1-1998Q1), both ADF and PP test show that all the variable is integrated of order 1 with significant of 5 percent. However, in the second sample (1998Q2-2017Q1), both ADF and PP test show that housing price, real GDP and CPI are integrated of order 1 and interest rate is stationarity in level. Since both test show that none of the variables is I (2), we proceed to the bounds testing procedure.

In the test we include both constant and trend terms and employ the SIC for the optimal lag order in the ADF test equation. In the first sample (1980Q1-1998Q1), both ADF and PP tests show that real GDP, CPI and interest rate are integrated of order 1 and only housing price is stationarity in level. However, in the second sample (1998Q2-2017Q1), both ADF and PP tests

show that housing price, real GDP and CPI are integrated of order 1 and interest rate is stationarity in level. Since both tests show that none of the variables is I (2), we proceed to the bounds testing procedure.

Next, we estimate the equation (4) using the standard OLS estimation method. The maximum lag order considered is 4. The Panel A in Table 3 shows the final specification of the NARDL model by trimming insignificant lags. Based on the estimated NARDL, we perform a test for the presence of cointegration among the variables using a bound testing approach and the result presented in Table 2.

Table 2: Bounds Test for Non-Linear Cointegration

Model specification LHPI = f (Ly, LCPI, MMR$^+$, MMR)	**F-statistic**		**Conclusion**	
1980Q1-1998Q1	7.8932		cointegration	
1998Q2-2017Q1	7.8103		cointegration	
	K=4, n=65		**K=4, n=70**	
Narayan (2005) critical value	**Lower bound I(0)**	**Upper bound I(1)**	**Lower bound I(0)**	**Upper bound I(1)**
1%	4.188	5.694	4.098	5.57
5%	3.068	4.274	3.022	4.256
10%	2.574	3.682	2.552	3.648

Notes: critical values are from Narayan (2005), given the small sample size.

The bound test concluded that the four variables (housing price, GDP, CPI and interest rate) co-move in the long run in both periods. The F-statistics 7.8932 and 7.8103 from two different time period exceed the critical upper bound. With this finding, we are in position to assess the housing price dynamics and its relation to the real GDP, CPI and positive and negative changes in interest rate.

The estimations are also examined through all diagnostic tests and the results are reported in Panel D in Table 3. The diagnostic test included Jarque-Bera statistics for normality, the LM statistics for autocorrelation up to order 2, and the ARCH statistics for heteroskedasticity up to order 2. In addition, Figure 2 graphs the CUSUM and CUSUMSQ statistics of the model in two different periods to test the structural stability of the model. All the results show that the model passes all the diagnostic tests which suggesting our model are normal distribution, absence of autocorrelation and heteroskedasticity and parameter stability in two different periods.

Table 3: Nonlinear ARDL Estimation Results

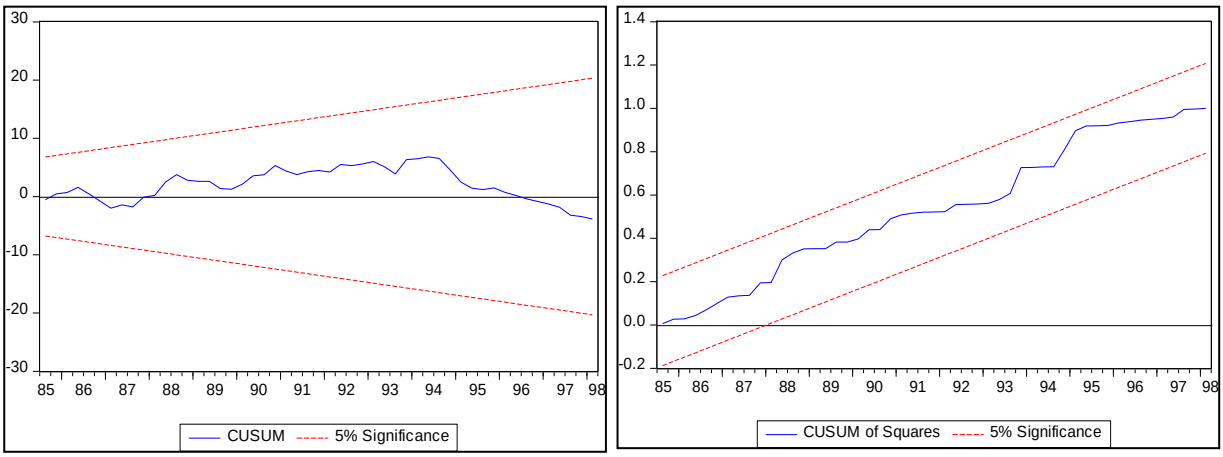
Panel A: Nonlinear ARDL				
	1980Q1-1998Q1		**1998Q2-2017Q1**	
Independent variable	**coefficient**	**P-Value**	**coefficient**	**P-Value**
C	-0.0550	0.2041	0.8090	0.0011
LHPI(–1)	-0.5387	0.0070	-0.0169	0.3748
LY(–1)	0.0197	0.0020	0.0201	0.3871
LCPI(–1)	0.4749	0.0149	-0.2364	0.0208
MMR^{+} (–1)	0.0003	0.1570	0.0304	0.0001
MMR^{-} (–1)	-0.0002	0.1648	-0.0081	0.0056
DHPI(–1)	-0.5701	0.0003		
DHPI(–2)	-0.7339	0.0000		
DHPI(–3)	-0.8663	0.0000		
DCPI	0.9295	0.0000		
DCPI(–1)	0.6167	0.0000		
DCPI(–2)	0.7116	0.0000		
DCPI(–3)	0.7398	0.0000		
ΔMMR^{+}			0.0390	0.0415
ΔMMR^{+} (–1)			-0.0418	0.0320
ΔMMR^{+} (–3)	-0.0018	0.0016		
ΔMMR^{+} (–4)	-0.0013	0.0086		
ΔMMR^{-}			-0.0161	0.0178
ΔMMR^{-} (–3)	0.0014	0.0001		
Panel B: Long run relation				
Constant	-0.1022	0.0469	47.7900	0.4165
LY	0.0365	0.0163	1.1859	0.5990
LCPI	0.8816	0.0000	-13.967	0.4781
MMR^{+}	0.0006	0.0885	1.7959	0.3593
MMR^{-}	-0.0004	0.2604	-0.4784	0.4295
Panel C: Asymmetric Test				
$\alpha_3 = \alpha_4$	0.00104	0.0007	2.2743	0.3705
Panel D: Diagnostic Checking				
R-squared	0.9904		0.3839	
JB	3.5717	0.1677	0.2595	0.8783

LM (1)	0.4492	0.5027	1.9976	0.1624
LM (2)	0.5083	0.7756	1.8232	0.1699
ARCH (1)	0.0155	0.9011	0.8163	0.3693
ARCH (2)	0.3870	0.8241	0.4434	0.6437

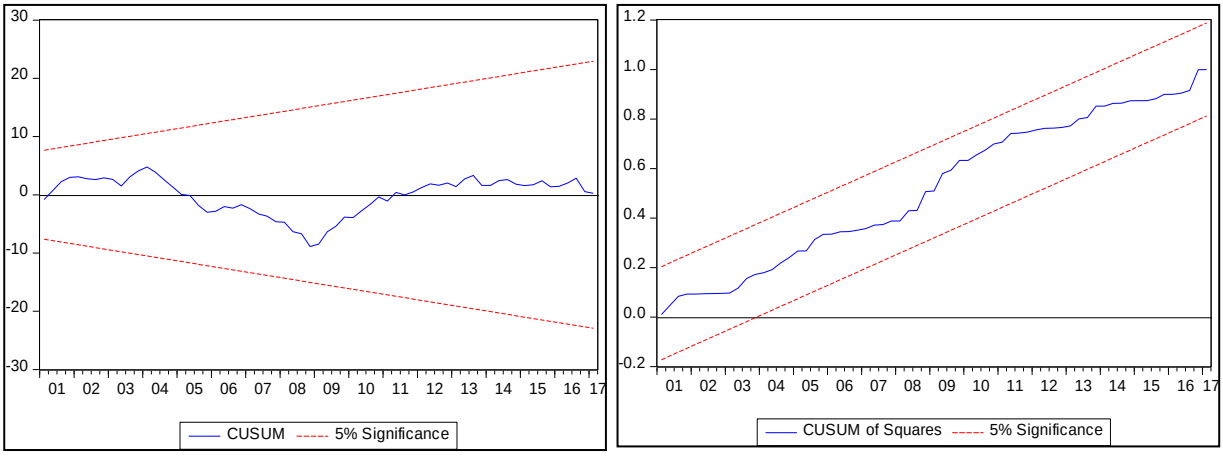
Note: The superscripts "+" and "-" denote positive and negative partial sums, respectively. JB is Jarque-Bera test for error normality. LM(.) is the LM test for error autocorrelation up to the lag order given in the parenthesis, and ARCH(.) is the ARCH test for autoregressive conditional heteroskedasticity up to the lag order given in the parenthesis.

Figure 2: CUSUM and CUSUM of Squares

(a) Model 1: 1980Q1-1998Q1



(b) Model 2: 1998Q2-2017Q1



From the results in Panel A in Tables 3, we compute the cointegration and long run equations for both periods. The long run relation is shown in Panel B. The long run coefficients of real income are positive and significant at 5 percent significance level, as should be expected in the pre-crisis. This is consistent with Holly *et al.* (2010). The results suggest that a 1 percent increase in real income is related to increase the expected housing price by roughly 0.4 percent but it is insignificant after 1998Q1. The long run coefficients of CPI are positive and significant

at 1 percent significance level in the pre-crisis. The results suggest that a 1 percent increase in CPI is related to increase the expected housing price by roughly 0.8 percent. However, it is insignificant and negative related after 1998Q1. The result is inconsistent with Tse (1996b). One of the possible explanations is during weak economic growth, even though the interest rates low, it is more difficult for people to afford higher price since their real incomes tend to decrease, Home buyers might decide to delay their purchases in hopes of seeing price declines.

In the asymmetric long run relation between the housing price and interest rate with increase in interest rate being significantly related to the housing price while the reduction in interest rate is not. This is the reason why some of the authors found it is positive (Öztürk and Fitöz, 2009) and negative (McQuinn and O'Reilly, 2008; Ibrahim and Law, 2014; Tang and Tan, 2015). This concludes that the interest rate pass-through to housing price is not complete. Our estimates suggest that a 10 percent increase in the interest rate is associated with the increase in the expected housing price in 0.006 percent. It is due to higher interest rates can negatively impact volume of home sales, but housing prices move according to the relative supply and demand and have generally increased in declining sales markets. The effect is very small and it disappeared after 1998Q1. We believe that the interest rate pass through may have effect on housing price before the Asian Financial Crisis (AFC) as compared with after the AFC.

Conclusion

This study aims to investigate the asymmetric impact on interest rate towards the housing price index in Malaysia. The chow test shows that the structural break occurred in the first quarter of 1998. Thus, a nonlinear Autoregressive Distributed Lags (NARDL) model has been applied for the period 1980Q1-1998Q1 and 1998Q2-2017Q1. Based on the results obtained from NARDL estimation, before the 1998Q2, interest rate increase is stimulating the value of housing price index, and interest rate decrease is reducing the value of housing price index. This indicates that the demand for houses tend to increase, given the consumer perception on the interest rate may go further higher and adding the cost of borrowing and vice versa. Furthermore, the result of the estimation also revealed that inflation and economic growth are both significantly affecting the housing price index. This is because inflation will make the construction cost to increase. Furthermore, people also regard the real estate as an effective inflation hedging tool and investment which may contribute to the increasing of housing price index. On the other hand, a growing economy indicating more jobs is available in a country for people to work and increase their affordability for demanding house and contribute to the increasing of housing price index.

After the Asian financial crisis, which is represented during the period of 1998Q2-2017Q1, the housing price index in Malaysia has been increasing progressively, given a relative lower interest rate set in the market. Hence, the results obtained from NARDL estimation indicated that interest rate increase and decrease are insignificant to influence the housing price index. This, however, indicates that the effort of money authorities to keep the credit at reasonable cost for complementing government's objective to fostering the national socio-economic have been causing the interest rate losing its control over the housing price index in Malaysia. On the other hand, inflation and economic growth are both insignificantly affecting the housing price index. The results shown that the real estate is no longer considered as an investment or inflation hedging tool for people to given that cost of living keep on increasing. Moreover, a weak economic growth in a country after the crisis is also making more people difficult in demanding houses.

In conclusion, this paper revealed that interest rate actually past through asymmetrically on housing price in Malaysia before the AFC rather that after the AFC. From a policy perspective, money authorities should be aware that there is a risk of expansionary monetary policy. This is because it may induce the nominal housing price to be inflated, and adding the cost of financing the mortgage loan. Moreover, the speed of rise in housing prices is usually much faster than wage growth. Hence, the government is recommended to implement a policy which helps to stimulate the economic growth by enhancing the household productivities. Besides that, personal income tax relief will help to support more people to afford in buying their first houses. On the other hand, the housing developers and the government should be working hand in hand to provide more low-cost houses for the low- income groups.

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