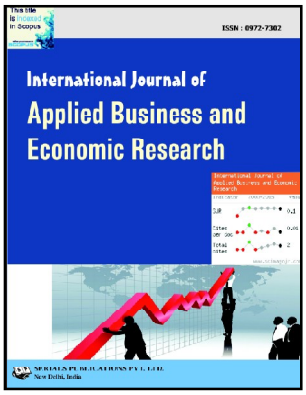

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Housing Affordability Dynamics: On the Contribution of Economic Growth Shocks, Credit Constraints and House Price Changes -For the Case of Malaysia -

Yip Chee Yin[1], Au Yong Hui Nee[2] and Abdelhak Senadjki[3]

[1,2,3] Faculty of Business and Finance (FBF), Universiti Tunku Abdul Rahman, Kampar, Perak, Malaysia
[1]corresponding-author: Yip Chee Yin, cyyip@utar.edu.my

Abstract: This paper attempts to examine the housing affordability threshold value obtained from different recognized definitions of housing affordability and thereafter construct a new housing affordability index which is based on disposable income and qualifying disposable income. Basing on literature reviewed, we define the threshold of affordability index as 130, below which housing is generally considered not affordable. Using instrumental variable regression, we derive the condition whereby once the housing affordability index dips below 130, housing affordability problem will set in, which condition will most likely occur when house price index reaches 162, gross domestic product growth at 5.32% and mortgage rate 5.57%.

Key words: Affordability Index, Threshold value, Qualify income, Instrument variable, J statistics

JEL classification: R21, R31, R38, H81, E51

1. INTRODUCTION

Adequate housing is a human right as enshrined in Article 25 of the Universal of Human Rights Declaration proclaimed by the United Nations in 1948. Housing provides shelter as well as a safe place for living and conducting various human activities that contribute to the wellbeing of the household. Affordable adequate housing is vital for social harmony and local economic development and prosperity (World Habitat Day 2016). In addition, for the majority of households, housing is a major motivating factor for saving and thus has significant influence on consumption. However, globally cost of housing has been rising and in many cases especially in urban cities, house prices are escalating, making housing affordability fast out of reach of many households, particularly the low as well as the middle income group. Affordability is the principal means of providing housing to people but the crisis of housing affordability confronting literally all cities and urban areas has now become a global problem. And if left unaddressed, this crisis could spiral and

destroy productivity of cities as contended by the Head of the United Nations agency Habitat, Dr. Joan Clos in an interview with the Financial Review on 3rd May 2017.

Affordability is the result of the interplay of various factors, among which most often mentioned are housing price itself and consumers' income. Affordability of housing is a continuum, the situation of affordability lies within a range from the most affordable to the least affordable and thereafter, the situation changes to one of unaffordable. It would be interesting if this turning point which is the confluence of the different affecting variables, could be identified and hence the position or value of each contributing variable at that point. This will present the possibility of tweaking one or more of the affecting variables to maintain affordability and preventing it from tipping over. This notion is incorporated in our proposed study on the significance of the influence of various factors on the dynamics of housing affordability, applied specifically in the Malaysian environment.

On a wider economic perspective, housing is an integral part of the construction industry. According to the 2014 Bank Negara Malaysia (BNM) Report, the construction sector contributed 4.3% of total GDP in the same year and which total output constituted of 27% of residential construction. In addition, the construction sector created an output multiplier of 1.9 times for the economy with the residential construction alone amounting to 2.0 times the economic output. This argument underlines the importance of housing as one of the key economic growth factors. As such, all the issues related to housing should be accorded proper management including housing affordability which could affect the socio-economic stability of the society while out of control escalating property prices could give rise to housing bubble and the devastating risks to the economy when the bubble bursts.

Malaysia has evolved through the past few decades from low income to that of an open upper-middle income nation (World Bank Overview – 2017). It has a steadily growing and rapidly urbanizing population (World Bank Group 2015), one of the prime factors for the rising demand for urban housing. It is not surprising that the nation has not been spared of the issues of housing affordability and accessibility. The situation is further exacerbated by other factors including rising cost of construction and investors buying which kept prices of houses on steep uptrend until many homebuyers, especially young homebuyers, lost hope of ever getting their first housing property. Nevertheless, as a result of stringent but cautious government housing policies and regulations, the following scenario is currently prevalent in the country. Malaysia has been focusing on the development of affordable housing for the low income households. As a result, initiatives such as "People's Housing Projects" and the "Malaysia My First Home Scheme" are implemented with the aim of direct provision of low-cost housing, or subsidizing the cost of housing for qualified home buyers, particularly first time home buyers. This focus on low income households inadvertently created the situation of growing concern of the middle-income earners who are neither eligible for social housing nor are able to afford private sector supplied houses. This issue is particularly prevalent in urban areas like Kuala Lumpur where homeownership is about 53.3%, as compared to Malaysian home ownership, 72.5% and urban homeownership 69.1%. (2010, Population and Housing Census). According BNM's Financial and Payment Systems Report 2016, the rate of increase in income has not kept up with housing prices growth rate since 2012 and moving forward, the country could expect the availability of affordable housing to worsen due to mismatch in demand and supply. This scenario underlines the pertinence of timely and on target intervention not only to balance demand-supply but more importantly on creating resources to improve the purchasing capacity of homebuyers.

This paper attempts to find an answer to the research question, to estimate the threshold values of the key determinants of housing affordability, with regard to when housing unaffordability will set in and suggestion of specific steps to overcome the problem.

In the foregoing discussion in the introduction section, we provide a general review of the answer to the above question. In section 3, we will examine the answer in more detail. According to global standards, housing affordability is a function of house prices and income. Housing market is said to be affordable if the median house prices is a multiple of median annual household income which is denoted by ϕ (Angel *et al.*. 1993; Angel 2000). By global standard, the widely used criteria for affordability is that the median house price value should not be more than 3 times the median annual household income that is the median house price should be equal to 3ϕ. Therefore, any median multiple larger than 3ϕ is considered unaffordable. In Malaysia, at the national level, the median multiple is 4.4ϕ. In Melaka it is 3ϕ indicating that it is at the threshold of affordability whereas in Kuala Lumpur, the value is 5.4 ϕ and Penang 5.2ϕ. This basic calculation reveals that we are facing a severe housing affordability problem particularly in Kuala Lumpur and Penang. But the question is when this unaffordability started does. Figure 1 suggests an answer to this question. In fact, we are facing affordability problem right from the second quarter of 2009 until then, almost a decade long. Why do we let housing affordability problem drags on for almost a decade? So far as we are aware, this issue and research question has not been looked into yet. Can we use fiscal and monetary regulations to avert housing affordability problem when it is in its initial formation? This paper also aims to solve this issue of when and how to avert housing affordability problem right at the formation or initial stage.

The rest of the paper is planned as follows: Section 2 presents a relevant literature review. Section 3 discusses the various definitions and analysis of housing affordability dynamics. Section 4 describes the methodology used in the analysis while section 5 presents the empirical and analytical analysis. Section 6 concludes this paper.

2. LITERATURE REVIEW

Literature on housing affordability abounds, basically driven by the need to provide more affordable housing. In recent years, governments in many countries have explored different ways of using statutory land-use planning system to exert influence on the provision of additional affordable housing (Paris 2007). Many of these articles focus on how best to address this affordability issue (Gabriel *et al.* 2005). However progress has been limited (Burke *et al.* 2007) as reflected by the fact that the issue is getting worse as the supply of affordable housing is low and falling (Chapman 2006; Wulff *et al.* 2001 and Beer *et al.* 2007). This state of housing affordability is reinforced by the findings of the following journal papers:

Lawson and Milligan' (2008) in their paper entitled "International trends in housing and policy responses" specifically for the case of Australia, at national level, reported there is a marked increase in using new strategies to promote new investment in affordable housing to low and moderate income households.

Then we have the provision contained in Section 106 of the Town and Country Planning Act 1990 in England requiring the planning authorities to entice a developer contributing to affordable housing as a consideration and condition of planning approval. In addition, the existence of social housing grant exerts a positive impact on the viability of a site for affordable housing by reducing the impact of a social housing target on residual land value (Gurran *et al.* 2007).

In Ireland, National legislation was introduced through the Planning and Development Act (2000) to enable local authorities requiring developers to contribute to social and affordable housing (Brooke 200, Norris 2006 and Gurran *et al.* 2007). The act uses planning gain mechanisms to deliver housing for rent and sale to low income households (Norris and Shiels 2007).

In the United States, it is mandatory for developer contribution to securing new affordable rental housing stock through the planning process. In the majority of cases, schemes, incentives are available to offset the financial burden of the contribution. Most authorities offer a combination of incentives which may include density bonuses, variations on subdivision, building design, parking, or landscaping requirements (Anderson 2005 in Gurran *et al.* 2007).

The literature reviewed above suggests that none of the articles focuses on how to prevent and pinpoint affordability problem right from the starting stage. This gap is rather obvious in the literature. One reason for this current oversight in this area could be that affordability index is not so much correlated to certain key housing determinants and these housing determinants selected are themselves correlated with one another, and thereby causing multicollinearity problem. This paper attempts to identify not only the threshold values of housing affordability index below which is considered as not affordable but also the threshold values of key housing determinants that have a direct bearing to housing affordability. Thereafter we suggest an effective solution to prevent affordability problem from setting in.

3. DEFINITION AND ANALYSIS OF HOUSING AFFORDABILITY DYNAMICS

Affordable housing is generally associated with the undue financial difficulties that households would experience in their efforts to obtain adequate housing. Milligan *et al.*. (2004) described affordable housing as the housing needs of people whose household income is insufficient to access adequate housing and thus would require assistance from the relevant authorities in order to be able to gain access to appropriate housing. In another words, it describes housing that assists lower income households in obtaining and paying for appropriate housing without experiencing undue financial hardship. Most of the definitions of housing affordability work on how to categorize undue financial hardship. Thus, without quantifying undue financial hardship, affordable housing generally refers to public, social or low cost housing. And consequently moderate income households are apparently side-lined. They can neither be considered as low income nor upper middle income households. Thus, one of the definitions that include this category of moderate income group is stated as:

> "Affordable housing is housing that is appropriate for the needs of a range of low to moderate income households and priced so that low and moderate incomes are able to meet their other essential basic living costs." (PRWG 2006 in Milligan *et al.* 2007)

Yet to-date, there is no universally accepted definition of affordability. The most commonly employed criteria for affordability is the 30/40 rule of dumb which assumes that housing costs take no more than a standardize thirty percent[1] of the gross income of a household in the lowest 40 percent income group, and when the allocation needed exceeds thirty percent housing is deemed to be unaffordable. It is conceivable that the lower middle income group falls within the lowest 40 percent of the income distribution. Therefore,

this 30/40 rule of dumb forms the principal criteria for defining housing affordability. No matter how different definition is defined, it ultimately must satisfy this principal criterion.

Let us consider and compare two widely used definitions of affordability based on the aforementioned rule of dumb. Firstly it is accepted that housing affordability is a function of house prices and income. As explained in the introduction, we let ϕ represents the median annual household income and median house price, *P*. With this, according to the rule of dumb, we can define the following relationship:

$$P = 3\phi \tag{1}$$

In other words, 3ϕ is the maximum median house price and above which houses are unaffordable. However, this definition is rather too general as it is based on gross income. It has not taken into account other household expenditure and moreover every household's expenditure varies quite a lot from one and another. Thus equation (1) is not a particular accurate guideline.

Examining the model in equation (1) in terms of house loan instalment per month and monthly income using an example of housing loan with period 20 years and total borrowing is 90% of the total house price, monthly instalment for the loan is about 23% of the monthly household income (derivation will be supplied upon request). Thus we have,

$$\text{Housingloan Instalment per month} = 23\% \text{ monthly income} \tag{2}$$

23% of monthly income is rather a very conservative figure since beside house loan, we have other household commitment like personal loan and household consumption and these items are different for different households. Thus it is highly not practical to say that households will use 77% of the monthly income for buying durable goods, fixed assets and every day consumption. In view of the above two facts that is the definition in equation (1) is computed based on gross income and the existence of different household commitments, and also it is globally accepted that the monthly instalment cannot exceed but close to 30% of the monthly income is considered as ideal, we need to look for another definition of housing affordability other than one stated in equation (1). As such, we consider one commonly used definition with specific modification for constructing affordability index which is shown below:

This second definition of affordability is based on qualify (disposable) income which in turn is defined as income minus mortgage (H) & non-mortgage (K) commitment(C=H+K)), and noncredit expenditure (E). Concerning C, it is always the practice that non-mortgage commitment is very small when compare to mortgage commitment. This is always the case for middle income group which we are interested in. For example, they borrow RM200000 for housing and they committed to credit card borrowing of around RM5000 only, giving K/H= 0.025= 2.5%. By this consideration, we assume that K will not create significant impact in the final computation. In addition, we obtain C ~ H. We also assume that H consists of basically the housing loan. Concerning non-credit expenditure (E), we have statistical data showing that $E \cong 30\% \text{ of } N$ where N represents the income. The original definition for qualify income (Q) is equal to income (N) minus the combination of mortgage and nonmortgage which is denoted by commitment (C) and noncredit expenditure (E) which is given by the following relationship.

$$Q = N - C - E \tag{3}$$

However E stands for rent, bills, food, travel, luxuries and so on, and these noncredit expenditures are very difficult to obtain as every household has different expenditures and priorities. As such, from statistical data, we conclude that E = 0.3N is reasonable. With this, we define qualify income as follows:

$$\begin{aligned} Q &= N - C - E \\ &= N - C - 0.3N \\ &= 0.7N - C \end{aligned} \tag{4}$$

income minus housing loan payment (C) both calculated and defined on a monthly basis. We further define the ratio of income to qualify income as index after converting into percentage. This definition has an advantage in the sense that it considers what is left after paying house loan as the base of computation. As for C, we only consider mortgage loan for housing and we do not include non-mortgage credit because its magnitude depend on individual household and moreover, the instalment for these non-mortgage credit are adjustable and much smaller amount than the mortgage loan. With this, we present, the second definition of affordability index which is given by equation (5)

$$\text{Affordability index} = \frac{N}{0.7N - C} \tag{5}$$

After computation and manipulation of equation (5), we find that the following statement is true.

Housing loan Instalment per month = 21% montly income

Derivation of equation (6) is shown in appendix A.

Therefore, definition of affordability as defined in equation (5) is friendlier since house loan instalment is about 21% of monthly income and this 21% is still below the rule of dumb 30/40 as described earlier but close to the number 30%. Moreover 21% is 2 percentage point below the definition as in equation (1). Additionally, we have made two reasonable assumptions in equation (1) but our final result as shown in equation (6) is still below the 30% of monthly income. This shows that our affordability computation has not been affected significantly by the two assumptions. Based on the above reasons, we adopt this definition as in equation (5) to construct our housing affordability index, the graph of which is shown in Figure 1. As the right hand side of equation (5) shown, it gives a value of more than 1. The higher this value indicates the household has more money to use for other household expenditure. As such, using the rule of dumb 30/40 of which 30% is the benchmark, we set affordability index 130 as the threshold value for affordability, beyond which is considered as unaffordable and above which, no affordability problem. Figure 1 shows the fluctuation of housing affordability index from 1994Q1 to 2015Q4. The graph suggests that housing affordability problem set in starting from 2009Q2 and getting worse from 2013 onwards. This starting point at 2009Q2 for unaffordable housing is not absolute as our definition of housing affordability is not absolute either. Thus this starting point could vary within 3 years limit (figure obtained from graphical analysis).

We further examine housing affordability from another angle. Figure 2 plotted real house price index to GDP per capita ratio which indicates unaffordability problem if the curve shows rising up consistently and rather sharply. This is because this trend suggests that rise in income cannot catch up with rise in house prices. This graph shows affordability problem started in February 2011, very close to our result of 2nd quarter 2009 but still within the 3 years limit as shown in Figure 1.

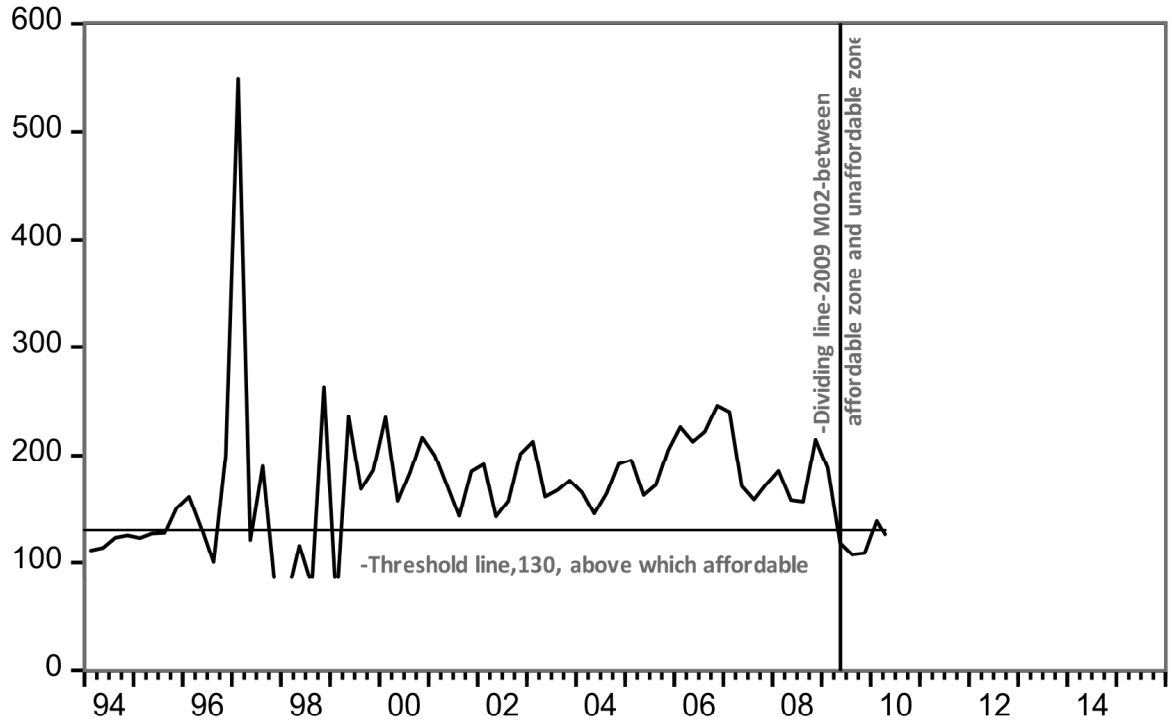

Figure 1: Changes of housing affordability index from 1994-2015

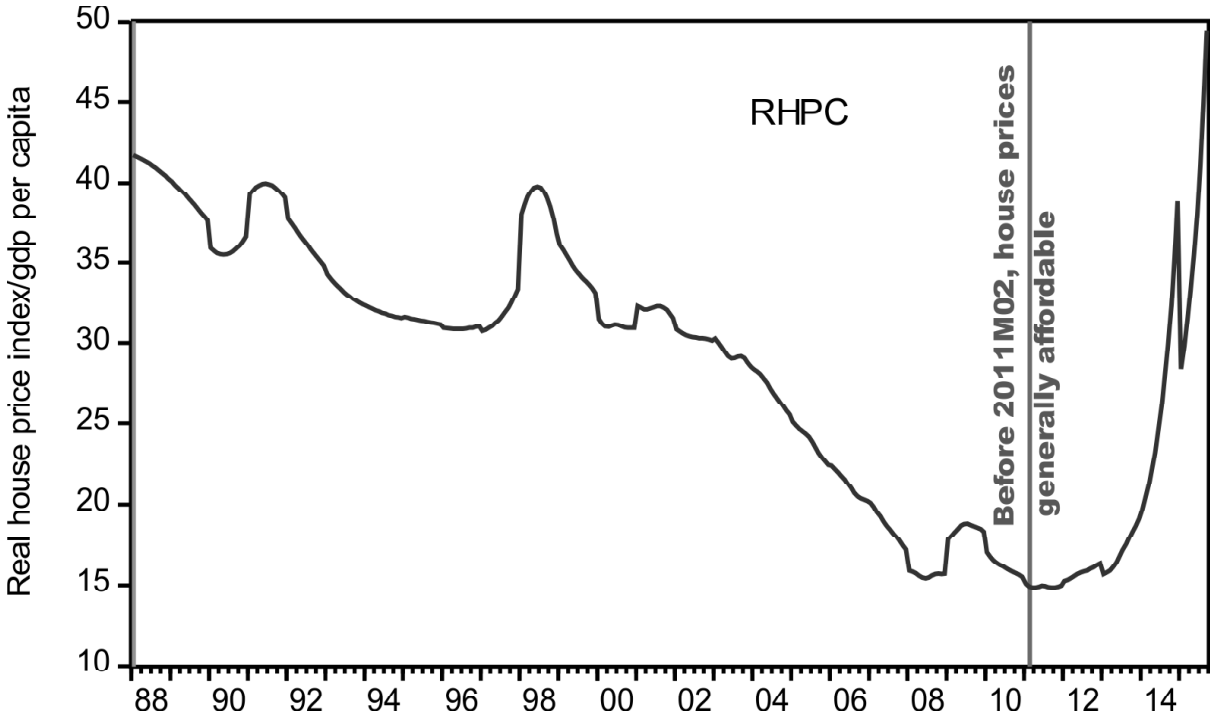

Figure 2: RHPC = Overall real house price index/gdp per capita

Source: Real house price index/gdp per capita is obtained from International Monetary Fund (IMF)

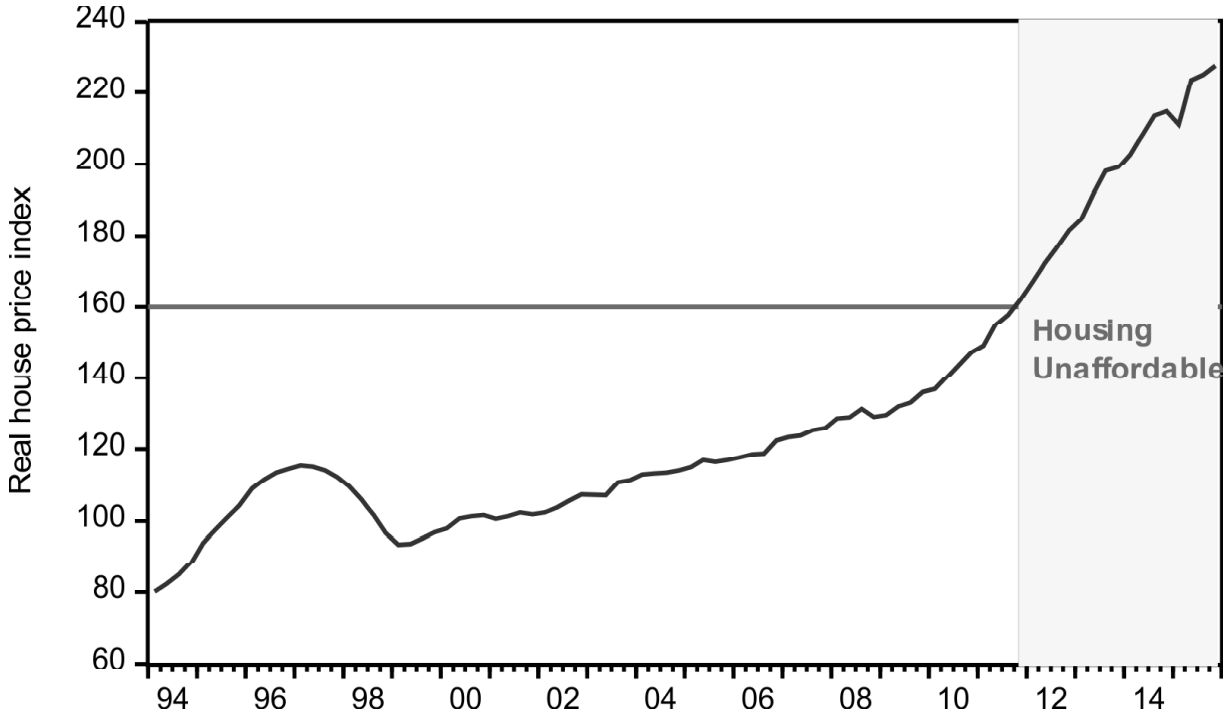

Figure 3: Real house price index

Note: Gray colour indicates housing unaffordable period

4. THE DATA AND METHODOLOGY

After going through literature review with regard to the suitability of methodology for the research, we decided that using regression analysis is sufficient to give reasonable good results. However regression suffers from many limitations. As such we use instrumental variable regression analysis instead.

The data: We use 7 sets of quarterly data (from 1994 quarter 1 to 2015 quarter 4) for the empirical analysis. They are as follows:

The Main Data Sets

1. Affordability index *(**AID**)*: Index computed by using equation (5) as described earlier.
2. Real house price index (***HPI***): House price index obtained from Valuation and Property Services Department (VPSM) of Malaysia. The computation of ***HPI*** has taken into consideration of the fluctuation of inflation rate at current time.
3. Mortgage rate (***MRT***): The data is downloaded from Bank Negara Malaysia website.
4. Gross domestic product percent (***GDP***): the data are also from Bank Negara Malaysia website.

The Instruments

5. Consumer sentiment index (***CSI***): This set of data is obtained from Statistical Department of Malaysia.
6. Exchange rate of RM/USD (***EXC***): This set of data is in terms of RM per USD, obtained from Bank Negara Malaysia website.

7. Global oil price/barrel (***OIL***): This set of data is obtained from IMF (International Monetary Fund).
8. Kuala Lumpur stock price index (***SPI***): This set of data is obtained from Statistical Department Malaysia.

THE METHODOLOGY

As the graphical analysis illustrates the actual situation, we use it as a tool to guide us to conduct controlled regression. As mentioned in the earlier section, housing affordability is a function of income and house price. Income refers to the disposable income but in Malaysia, it is very difficult to obtain the data if not impossible to find this income series. Therefore, we use GDP per capita as the proxy for the disposable income. There are several reasons for this choice. The main reason is that GDP per capita is considered as the average individual income. By right, median income is a better choice as it is not affected by outliers unlike average income. However, average income is a better measure for central tendency of the data set. Since the number of people involved is huge, a better central tendency measure is preferable.

Our three affordability determinants, *GDP, HPI* and *MRT* are chosen after in-depth literature review. The reasoning are as follows: House price (*HPI*) has direct influence but negative relationship on housing affordability and as such, it is only natural to use house price to forecast the trend of housing affordability. As mortgage rate (*MRT*) affects the availability of the housing loan directly, we expect it has a negative relationship with housing affordability. Mortgage rate is one of the key determinants for housing prices. The most important key factor is *GDP* growth which has a positive relationship with income. Thus the bottom line for housing affordability is *GDP* growth and we expect them to have a positive relationship.

As changes in *GDP* involved with many key macro-determinants and rather frequency, we intend to track the short term dependency of housing affordability on house price index, *GDP* growth and mortgage rate. We run regression analysis four times, one on house price alone and then on house price and mortgage rate with the objective to find out at what house price the housing affordability started to become unaffordable and also what is the range of most suitable mortgage rate needed to ensure the housing is affordable. Next, we run regression of housing affordability on house price index and *GDP* growth. After that we run the regression of affordability index on all the three regressors. With that we construct the following four models which are used in the analysis.

$$\Delta AID_t = \beta_0 + \beta_1 \Delta HPI_t + U_t \quad (5)$$

$$\Delta AID_t = \beta_0 + \beta_1 \Delta HPI_t + \beta_2 \Delta MRT_t + U_t \quad (6)$$

$$\Delta AID_t = \beta_0 + \beta_1 \Delta HPI_t + \beta_2 \Delta GDP_t + U_t \quad (7)$$

$$\Delta AID_t = \beta_0 + \beta_1 \Delta HPI_t + \beta_2 \Delta MRT_t + \beta_3 \Delta GDP_t + U_t \quad (8)$$

with *AID, HPI, MRT* and *U* denote Affordability Index, House Price Index, Mortgage Rate and the error term respectively. We use instrumental variables like consumer sentiment index (*CSI*), oil price (*OIL*), exchange rate (*EXR*), stock price index (*SPI*) and first lag of affordability index, *AID*(-1) as instruments.

We follow the following steps to conduct the regression analysis:

1. We test for the existence of unit root for each of the variables to ensure that all are stationary series. If not stationary, we perform the first difference to turn it into a stationary series and only then we perform the regression.

2. Then we perform the diagnostic test and also the Granger causality test for any sign of the existence of simultaneity of the equation. Any way the test results may not be crucial because we are using instrumental variable regression.

3. We conduct the J statistics test for exogeneity for the case of over identified condition whereby m > k where m is the number of instruments and k the number of regressors. This is to ensure all the instruments, *CSI, EXR, OIL, SPI* and the first lag of *AID* are all exogenous variables. If the J statistics test returns a result of fail to reject H_0, then the relevant instruments are exogenous.

5. EMPIRICAL AND ANALYTICAL RESULTS

Graphical analysis results

The starting point of analysis is the definition of housing affordability index which we define the threshold value to be 130 following the globally accepted threshold value. Below 130 suggests housing unaffordability and above it housing is affordable. Figure 1 shows the starting time for housing unaffordability. The recent problem started in and around quarter 2 of 2009. However, this starting time cannot be pinpointed accurately from the graph as Figure 2 suggests the starting time for housing affordability is in 2011.Thus we have to give it an allowance or rather, we use time interval for the starting of housing affordability problem. The interval is chosen as between 2009 to 2011. This starting time interval together with the threshold of housing affordability index will serve as a guide for us to conduct regressions as specified in the four regression models.

Regression analysis results

The instrumental variable regression results for model 1 to 4 in equation (5) to (8) are shown in Table 1. Each of the estimated four models are represented in equation (9) to (12) respectively. The values in the parentises below the coefficients denotes the respective p-value for t test.

$$\text{Model 1: } \hat{AID} = \underset{(0.00)}{246.4} - \underset{(0.00)}{0.72}\,HPI \tag{9}$$

$$\text{Model 2: } \hat{AID} = \underset{(0.00)}{266.4} - \underset{(0.00)}{0.95}\,HPI + \underset{(0.04)}{3.29}\,GDP \tag{10}$$

$$\text{Model 3: } \hat{AID} = \underset{(0.00)}{406.8} - \underset{(0.00)}{1.28}\,HPI - \underset{(0.01)}{12.93}\,MRT \tag{11}$$

$$\text{Model 4: } \hat{AID} = \underset{(0.00)}{399.8} - \underset{(0.00)}{1.31}\,HPI - \underset{(0.11)}{13.41}\,MRT + \underset{(0.30)}{3.08}\,GDP \tag{12}$$

Based on these four estimated equations (9), (10), (11) and (12), and also Figures 1, 2, and 3, we analyze the actual market situation and suggest how precautions can be taken to avoid housing affordability problem.

Analytical results

1. Based on the definition of housing affordability, it is defined that the threshold value of affordability index is equal to 130. Any value less than 130 is considered as unaffordable and any value that is more

Table 1
Regression analysis results

	Models			
Regressors/Coefficients	*M1*	*M2*	*M3*	*M4*
Intercept	246.4(0.00)	406.8(0.00)	266.4(0.00)	399.8(0.00)
HPI	-0.72(0.00)	-1.28(0.00)	-0.95(0.00)	-1.31(0.00)
MRT		-12.92(0.01)		-13.41(0.11)
GDP%			3.29(0.04)	3.08(0.30)
R Squared	0.196	0.535	0.531	0.177
Adj R Squared	0.187	0.522	0.518	0.147
Pro(F Statistic)	0	0	0	0
Pro(J statistic)	0.354	0.578	0.193	0.521
Durbin-Watson stat	1.696	1.739	1.923	1.62
Instruments	2,1,7,5	4,1,7,2	4,1,2,7	1,2,7,9

Note: Instruments: OIL (1), EXR(2), SPI(3), CSI(4), AID(-1)(5), AID(-2)(6): OIL=oil, EXR = exchange rate, SPI = stock price index(7), CSI = consumer sentiment index (8), AID = affordability index, AID(-1)(9), affordability index lag1, Hloan (10)
Regressors: HPI = house price index, MRT = mortgage rate, GDP% = gdp growth in %

than 130 is affordable. With this, we substitute the threshold value into equation (9), we obtain the following result:

$$\hat{AID} = 246.4 - 0.72HPI = 130$$
$$\text{Threshold value of } HPI = 162 \tag{13}$$

This value of 162 which is the threshold value, is consistent with what is estimated by using graph in Figure 3. Thus, if unaffordable we would have the following condition for house price index values.

$$HPI > 162 \tag{14}$$

2 As house price is the key determinant of affordability which depends largely on income. But income is also largely determined by GDP growth. Thus, another key determinant of affordability is GDP growth. Equation (10) describes how affordability depends on house price and GDP growth. Using the threshold value of affordability and house price, we can obtain the threshold value of GDP growth as shown in equation (15).

$$\hat{AID} = 266.4 - 0.95HPI + 3.29GDP = 130$$
$$0.95HPI = 136.4 + 3.29GDP$$
$$GDP = 5.32 \tag{15}$$

Thus we have the threshold value of GDP = 5.32, meaning for unaffordability,

$$GDP < 5.32 \quad (16)$$

3 Beside house price and GDP growth, mortgage rate is the third important determinant of affordability. However, mortgage rate is determined and set partly by the administrator for the sole purpose to cool down or fuel the property market. Thus mortgage rate is an effective tool to influence the market or to activate the market. The threshold value for mortgage rate can be obtained by using equation (11) and by substituting the threshold value of house price and affordability index into the equation.

$$\begin{aligned} \hat{AID} &= 406.8 - 1.28HPI - 12.93MRT = 130 \\ 406.8 - 1.28 \times 162 - 12.93MRT &= 130 \\ MRT &= 5.57 \end{aligned} \quad (17)$$

Since mortgage rate and affordability is negatively related, for unaffordability the mortgage rate should be more than the threshold value.

$$MRT > 5.57 \quad (18)$$

Thus for unaffordability to occur, we should have the following sets of condition:

$$HPI > 162 \quad GDP < 5.32 \quad MRT > 5.57 \quad (19)$$

6. CONCLUSION

We have modified a common definition of housing affordability as illustrated in equation (5). Using the well-received threshold value for affordability index of 130 and using instrumental variable regression, we have obtained the threshold value of housing price index, GDP growth and mortgage rate with respect to housing affordability. As a whole, the threshold conditions for unaffordability are as follows:

$$HPI > 162 \quad GDP < 5.32 \quad MRT > 5.57$$

where *HPI, GDP* and *MRT* denote housing price index, gross domestic product in percent and mortgage rate respectively. Thus if conditions as specified in equation (19) prevailed, intervention policy has to be put in place, such as adjusting downward the mortgage rate which will help to reduce the cost of housing loans or boost up economic growth which should bring about higher growth in real income. The government could also further encourage by incentives or have regulations that compel developers to increase the supply of affordable homes while simultaneously increase social housing and appropriate financial plans to assist first time homebuyers. Appropriate intervention before affordability stress sets in will help in balancing the housing market both in terms of supply-demand as well as housing price trend.

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