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Detection and forecasting of housing price bubbles in Indonesia, Malaysia, and Singapore

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ABSTRACT

Houses are commodities to fulfill basic human needs, so the demand tends to continually increase. The research aims to assess the potential for a housing price bubble and to forecast house prices in the future. The data used in this study are secondary data from three countries, Indonesia, Malaysia, and Singapore. The method used to detect a housing bubble involves comparing the data of the House Price Index with the Consumer Price Index. The observations show that the trend in house prices in Malaysia and Singapore continues to increase each year. Indonesia exhibits a fluctuating trend in house prices. The highest value of Malaysia's housing bubble ratio is 1.94 in the 2nd quarter of 2020. Based on the ARIMA modeling results, the forecasting of the House Price Index in Indonesia, Malaysia, and Singapore shows a positive trend.

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Rumah merupakan komoditas untuk memenuhi kebutuhan pokok manusia, sehingga permintaannya cederung terus mengalami peningkatan. Penelitian bertujuan untuk mengkaji potensi adanya gelembung harga rumah sekaligus melakukan forecasting harga rumah pada masa yang akan datang. Data yang digunakan dalam penelitian ini merupakan data sekunder di tiga negara yaitu Indonesia, Malaysia, dan Singapura. Metode yang digunakan untuk mendeteksi housing bubble dengan memperbandingakan data indeks harga rumah dengan indeks harga konsumen. Hasil pengamatan menunjukkan, tren harga rumah di Malaysia dan Singapura terus mengalami peningkatan tiap tahunnya. Indonesia memiliki fase naik turun untuk pergerakan harga rumah.

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1. Introduction

The ownership of a house holds profound significance in the lives of individuals and society. Someone owning a house is not merely about having a place to live but serves as a foundation of security and stability for the family. Owning a private home instills a sense of possession and control over the living environment, establishing a strong foundation for daily life. In the present era, the motivation for buying a house has undergone a significant shift from meeting basic needs to a broader perspective, viewing it as an investment. More and more individuals perceive homeownership as a potential means to generate financial gains in the long term. This factor is reflected in property market trends in various regions, where house prices tend to continually rise.

Over the past decade, Malaysia has experienced a 32% increase in house prices, and this upward trend is a cause for concern for various parties, particularly the public and the government as policymakers. The main problem is whether this increase is due to a cyclical adjustment turning point or other factors, such as material and macroeconomic factors. (Hamid et al., 2022). This perception is driven by the belief that property is a safe and reliable asset, as its value tends to be appreciated over time. In this context, a home is not just a place to live but also a promising investment instrument. Homes, especially in the capital region of DKI Jakarta, are an investment vehicle for those searching for homes in the present era (Mu'tashim et al., 2021). In addition to hoping for an increase in house prices, home seekers also project their homeownership to be rented out. They can allocate this as an additional source of income.

The increase in housing demand is also driven by a relatively low-interest rate environment and the availability of various financial products, such as mortgages with more flexible credit requirements, further encouraging individuals to invest in homeownership. Government policies supporting the property sector, such as tax incentives or housing subsidy programs, can also strengthen this motivation. However, this shift also poses some challenges. The appreciation of housing prices in Singapore can be associated with a surge in real capital inflows to Singapore (Chow & Xie, 2016). The mobilization of capital through Foreign Direct Investments (FDI) sources for the purchase of real estate by foreigners in Singapore has increased the index of private residential property prices. This phenomenon strengthens the notion that the shift in home purchasing motivations, low interest rates, and the availability of long-term credit have successfully triggered an increase in home prices that could potentially lead to a housing bubble.

A recent study in Malaysia indicates that most houses in Malaysia are largely unaffordable due to the imbalance between median house prices and household incomes (Ismail, 2019). Deviation of prices from the affordability of the community can trigger a housing bubble in Malaysia. A bubble situation can occur when asset prices exceed the fundamental value of that asset (Brunnermeier & Julliard, 2006).

This can happen because current owners believe asset prices can be higher in future sales. Home prices, like any other asset, exhibit relatively high volatility, making the residential property market sensitive to various factors, such as macroeconomic factors and material costs. Housing price bubbles, in some cases, can create difficulties in access for those who want to own a home for residential purposes. Additionally, the financial risks associated with property market fluctuations can impact the financial stability of individuals and society at large.

A housing price bubble, left unchecked, can eventually burst. The bursting of a housing price bubble can result in a sudden decline in property values, which can negatively affect homeowners, financial institutions, and even the overall economy. This phenomenon occurred in the United States during the 2008 subprime mortgage crisis. The subprime mortgage crisis originated from naive expectations of a continuous rise in residential property prices. This motive was supported by the creation of derivative financial products packaged as sourced from subprime mortgages, which were bundled into mortgage-backed securities (MBS) or collateralized mortgage obligations (CMOs), leading to a disaster for America and the world. The subprime market experienced a booming-bust scenario with classic loan scenarios, rapid market growth, loosening collateral standards, deteriorating loan performance, and a decrease in risk premiums (Demyanyk & Van Hemert, 2011). Lehman Brothers, the fourth-largest financial institution in the U.S., faced bankruptcy, resulting in hundreds of billions of dollars in losses due to this crisis. The U.S. government had to bailout Citigroup, Bank of America, AIG, JP Morgan Chase, Goldman Sachs, Morgan Stanley, Amex, Chrysler, and General Motors with up to US$ 700 billion due to the financial issues these companies were facing (https://feb.ui.ac.id/2022/01/31/budi-frensidy-kilas-balik-krisis-finansial-2008/ accessed at 19 Dec 2022 at 12:56).

The risks of potential housing price bubbles need to be minimized to ensure affordability guarantees for the community. A conducive investment climate also needs to be created for investors operating in the housing sector. One effort to minimize the potential housing price bubble is through early detection of housing bubbles and forecasting future housing prices. Early detection of the housing bubble ratio can serve as a guide for the government in policymaking related to asset price control. Meanwhile, forecasting housing prices can provide insights and considerations for individuals seeking basic housing needs and for investors when allocating their funds to the housing sector. Therefore, research becomes urgent to be conducted, given the importance of the implications of this study.

2. Literature Review (optional)

Asset Bubble

A bubble in economic situations (Aliber, Kindleberger, & McCauley, 2015) is interpreted as an upward price movement over an extended period, followed by a burst. Asset price bubbles are characterized by euphoria, which is excessively optimistic expectations about the future economic fundamentals, lasting for several years and then bursting (Shiratsuka, 2003). Specifically, asset bubbles (Mattoon, 2007) are defined as a situation in which the asset's price exceeds its fundamental value. Fundamental value is the expected value of all dividends generated by the asset during its lifespan, accurately discounted to reflect the present value of dividends paid on future dates. If an asset's price exceeds its fundamental value, it can be considered that the asset is overvalued. This is because it is not reasonable for the overall community to pay such a price. This situation occurs in a risky asset market where the demand price process is higher or equal to the supply price process (Kühn, 2023). The asset price bubble in real estate can be categorized as a rational bubble (Brunnermeier & Julliard, 2006)

Bubble Rational

Frational bubble is generated by unrelated events and can also be caused by the spread of specific issues (Kubicová & Komárek, 2011). The bubble arises due to investors' expectations as they seek to satisfy themselves regarding the future growth of asset prices that are not directly related to its fundamentals. The motivation behind these investor actions is triggered by waves of optimism and excessive sentiment. A rational bubble will continue to grow until it reaches the expected rate of return. These actions represent an effort to achieve the expected profits for investors by selling the asset at a certain profit in the future.

Rational bubbles emerge motivated by non-fundamental factors (Blanchard & Watson, 1982). The market price of assets can be decomposed into the following components:

$$P_t = P_t^f + B_t$$

Where:

P_t: the market price of assets

P_t^f: assets of fundamental value

B_t: bubble components

Blanchard and Watson contribute to determining the dynamics of bubbles, which grow at a rate *r* with probability π and will burst with complementary probability (1 - π). Bubbles can experience forecasting errors u_t, is:

$$B_{t+1} = \begin{Bmatrix} \frac{(1+r)B_t}{\pi} + \pi_{t+1} \\ 0 + u_{t+1} \end{Bmatrix} \quad \begin{matrix} \text{With probability } \pi \\ \text{With probability } (1-\pi)\ E(u_{t-1})=0 \end{matrix}$$

Where:

r: long-term average return on assets

E: expectation variable

The phenomenon of a bubble burst begins with the return on assets growing faster than the journey of the average return. This is due to investors' assumption that asset prices will continue to rise, yielding the expected rate of return. The actual event of the economic bubble bursting will occur in the future due to the desire of investors to consistently seek the satisfaction of expected profits.

Housing Bubble

A housing bubble occurs when house prices grow further beyond the limits that should be set by fundamental value without being accompanied by the adoption of more sophisticated financial innovations to support its growth (Baker, 2008). The housing price bubble has three dimensions of significant implications (Feng & Laura, 2015). First, both the level and the rate of growth of house prices themselves are indicators of the housing price bubble. Second, comparing rental income to the price ratio over time across the entire market without considering changes or variations in operating costs can be misleading in measuring the housing price bubble. Finally, at least the expected appreciation of house prices is supported by fundamental factors. However, this last statement remains a subject of debate among researchers.

Housing Bubble Indicator

Housing as an economic good has strength in terms of demand, known as demand theory. Equilibrium demand (D_t) for the current housing stock is a function of price. (P_t), accompanied by demand variables such as income, credit interest rates, population growth, wealth, and foreign demand ($X_{d,t}$) (Mahalik & Mallick, 2011). Thus, the long-term demand function for housing can be written with the following equation.

$$D_t = D(P_t, X_{d,t})$$

The linear equation form is:

$$D_t = \beta_0 + \beta_1 P_t + \beta_2 X_d, t + \varepsilon t$$

The most commonly used housing price model is the inverted demand equation, as follows:

$$P_t = f(X_{d,t}, X_{s,t}, tZ_t)$$

Where *Zt* refers to other qualitative variables that influence housing prices, however, economic theory does not automatically impose limitations on variables. It is possible that there are many undefined factors influencing housing prices. This is useful for making some observations about the main determinants of housing prices in the housing markets of various countries. This is because it is difficult to capture all factors that explain house prices.

Other researchers have also identified factors influencing housing prices, leading to the creation of a housing bubble. Factors influencing housing prices include interest rates, inflation, national income, and the stock market index (IHSG). Empirical evidence also indicates that the U.K. experienced a housing bubble boom influenced by the availability of credit and housing demand pressures (Dokko et al., 2011). Recent studies on housing price bubbles have also been conducted in Japan and its economic cooperation partners, namely the United States, the Eurozone, and the United Kingdom. The research findings provide new empirical evidence on the timing of housing bubbles, spillover volatility, and the transmission of housing price bubbles (Bago, Akakpo, Rherrad, & Ouédraogo, 2021). The spillover effects of volatility and the transmission of bubbles between Japan's real estate markets and its economic cooperation partners over several periods need to be a significant concern for developing coordinated real estate policies to address the risks of a global real estate bubble.

3. Research Method

The data used in this study is secondary data regarding the Consumer Price Index (CPI) and Housing Price Index (HPI) in three countries, Indonesia, Malaysia, and Singapore, from 2002 until 2022 (84 data). The data was obtained from the official Trading.com and Bank Indonesia websites. Empirically, this study attempts to examine the early detection of indications of a bubble economy and forecast housing prices using time series data. The initial step taken is to observe indications of a residential property price bubble by comparing residential property price index (IHPR) data with the consumer price index (CPI). Furthermore, ARIMA is used to model and forecast house prices in the future in three countries. The formula for calculating the housing price ratio is

$$housing\ price\ ratio = \frac{IHPR}{IHK}\ X\ 100$$

The housing price ratio will be calculated with a baseline figure of 1. The levels of the bubble in empirical research on asset bubbles in the USA fall into the following levels (Keen, 2013):

1) Small bubble: The ratio of asset prices to CPI reaches 2: 1
2) Peak bubble: The ratio of asset prices to CPI reaches 4: 1
3) Bursting bubble : The ratio of asset prices to CPI reaches 10: 1

The analysis used to model and forecast house prices in three countries is ARIMA.

ARIMA

ARIMA is a time series data forecasting model introduced by Box-Jenkins. ARIMA disregards independent variables and assumes that previous errors and values will provide information for forecasting (Mohamed, 2020). ARIMA(p,d,q) is a combination of two models, namely Autoregressive (A.R.), denoted by p, and Moving Average (M.A.), denoted by q. Meanwhile, d represents the differencing process. The general form of the ARIMA model is as follows:

$$Y_t = b_0 + b_1 Y_{t-1} + \cdots + b_p Y_{t-p} - a_1 e_{t-1} - \cdots - a_t e_{t-q} + e_t$$

With Y_t is the data time series, b_0 is constanta, Y_{t-1}, Y_{t-p} is data in time $t - i$, e_t is an error in time t, e_{t-1}, e_{t-q} is an error in time $t - j$, b_1, b_p is the i^{th} A.R. parameter, and a_1, a_t is the q^{th} M.A. parameter.

ARIMA modeling requires stationary data to be estimated, so a stationarity test using the Augmented Dickey-Fuller test needs to be performed. The estimation of the ARIMA model can be done by *examining* the AutoCorrelation Function (ACF) and Partial AutoCorrelation Function (PACF) plots with the help of a correlogram (Purbasari, Anggraeny, & Ardiningrum, 2021).

4. Result and Discussion

The Consumer Price Index and House Price Index data are presented in the form of indices with a range of values from zero to 12. The following table describes the House Price Index and Consumer Price Index data for three countries, namely Indonesia, Malaysia, and Singapore.

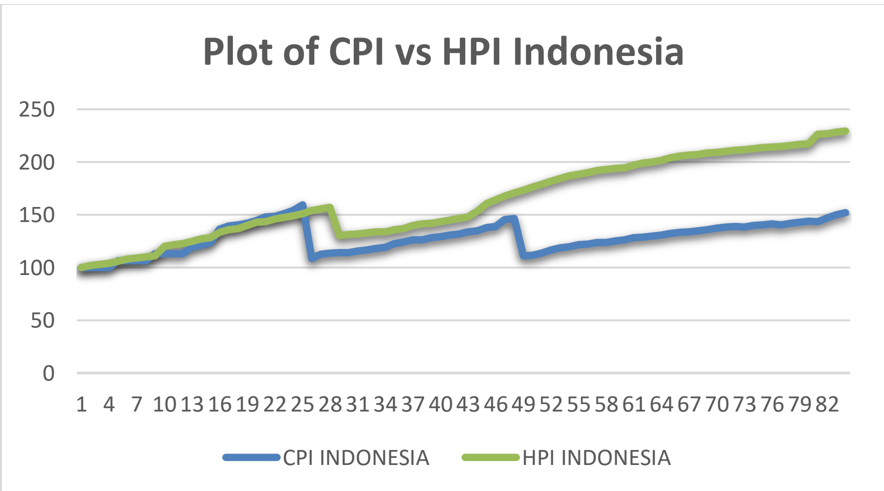


Figure 1. Plot CPI vs HPI Indonesia

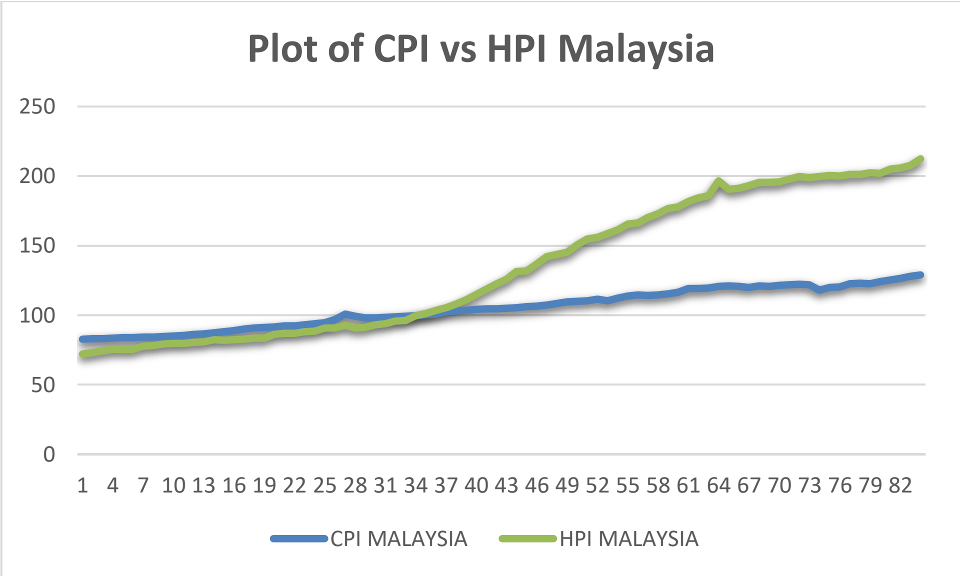


Figure 2. Plot CPI vs. HPI Malaysia

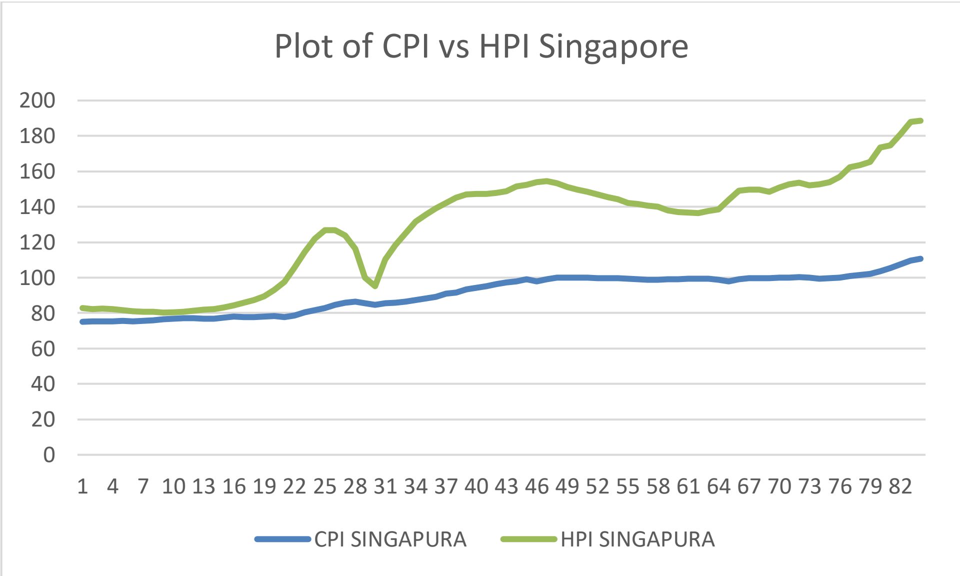


Figure 3. Plot CPI vs. HPI Singapore

Stationery Test

Table 1. Stationery Test Value

		Indonesia		Malaysia		Singapore	
		t-stat	Prob	t-stat	Prob	t-stat	Prob
ADF Test	Level	-0.382041	0.9065	-0.001077	0.9552	-0.612462	0.8612
	1st difference	-8.420025	0.0000	-2.026822	0.2750	-5.290460	0.0000
	2nd difference	-10.45374	0.0001	-8.700131	0.0000		-

Stationarity testing was conducted using the Augmented Dickey-Fuller (ADF) test. In Table 1, it can be observed that the stationarity of HPI for Indonesia at the level has a t-statistic value of -0.382041 and Prob. of 0.9065. It can be concluded that the data is not stationary, and differencing is needed. After the first differencing (1st differencing), the t-statistic value is -8.420025, and Prob. Is 0.0000. However, in the first differencing, the ACF and PACF plots did not provide significant results to estimate the ARIMA model, so the data needs to be second differenced (2nd differencing). The differencing result yields a t-statistic value of -10.45374 and Prob. of 0.0001, indicating that the data is now stationary.

Stationarity testing for Malaysia's house price data in Table 1 with the ADF test shows a t-statistic value of -0.001077 and Prob. of 0.9552 at the level. The Prob. Value compared to the alpha value (5%) suggests that the data is not stationary, so differencing is needed. The ADF test result after the first differencing produces a t-statistic value of -2.026822 and Prob. of 0.2750. It can be concluded that the data is not stationary after the first differencing, so the second differencing is performed. The ADF test result for the second differencing produces a t-statistic value of -8.700131 and Prob. of 0.0000, indicating that the data is now stationary.

Stationarity testing for Singapore's house price data in Table 1 with the ADF test shows a t-statistic value of -0.612462 and Prob. of 0.8612 at the level. The Prob. Value compared to the alpha value (5%) suggests that the data is not stationary, so differencing is needed. The ADF test result after the first differencing produces a t-statistic value of -5.290460 and Prob. of 0.000. It can be concluded that the data is stationary after the first differencing

Detection of Housing Bubble and Stocks

The detection of housing bubbles in Indonesia, Malaysia, and Singapore was conducted by observing from the first quarter of 2002 to the fourth quarter of 2022. The Consumer Price Index (CPI) is used as a benchmark ratio to determine the level of bubbles for each instrument. The following are the results of the analysis of the calculation of housing bubbles in Indonesia, Malaysia, and Singapore.

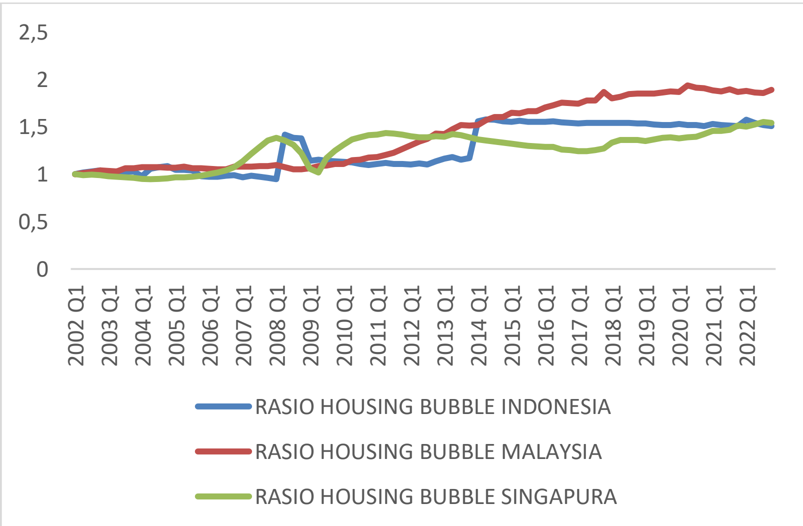


Figure 4. The ratio of housing prices to CPI

Indonesia experienced the lowest housing bubble ratio at 0.948616 in the first quarter of 2008. The highest housing bubble ratio was 1.579414 in the second quarter of 2014. Prices in 2008 tended to be lower compared to the movement of the consumer price index, triggered by the global financial crisis originating in the United States. The economic downturn due to the subprime mortgage crisis led to a decrease in demand and a movement in housing prices in Indonesia. Indonesia is still on the safe side from the potential housing bubble as the maximum housing bubble ratio (1.579414) is still below the small bubble criteria, which is 2. However, the government must continue to monitor the movement of house prices and economic control to ensure that the housing bubble ratio remains within a safe range. This is to provide a healthy environment for the real estate investment world and ensure affordable prices for consumers.

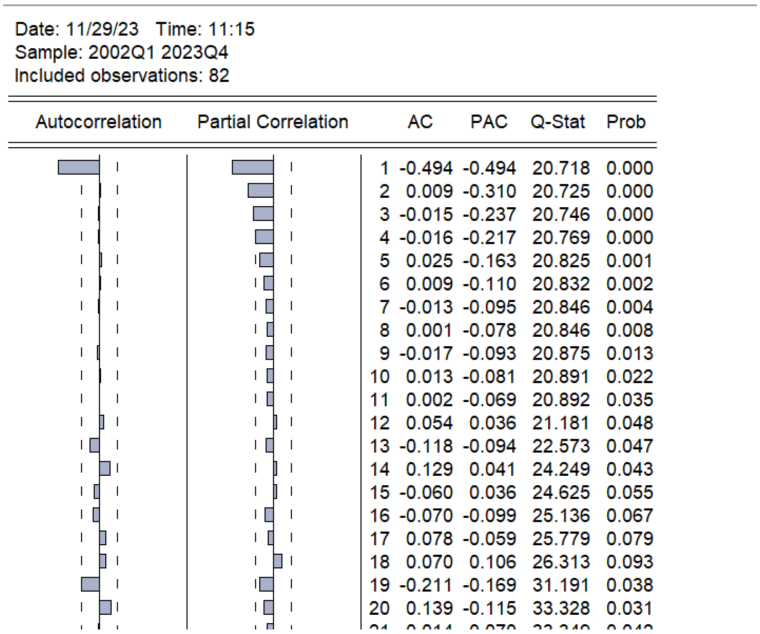
The lowest housing bubble ratio for Malaysia was 1.010941 in the second quarter of 2002. Meanwhile, the highest ratio was 1.94 in the second quarter of 2020. Based on the above graph, it can be seen that Malaysia has the most potential to experience a housing bubble. Observations show that from 2015 to 2022, the housing bubble ratio continues to increase with a range of ratios between 1.6 and 1.9. Based on bubble criteria, Malaysia is almost experiencing a bubble price for the housing sector with a maximum ratio of 1.94. The government needs to conduct an analysis to observe the movement of house prices. In addition, economists need to examine the fundamental factors that trigger the significant difference between the movement of the housing price index and the consumer price index.

Singapore has a fluctuating housing bubble ratio. The lowest ratio occurred in the second quarter of 2004, while the highest ratio was in the second quarter of 2022. Although Singapore has a trend of housing bubble ratios that tend to fluctuate more compared to Indonesia and Malaysia, the ratios during the years 2002 to 2022 are still categorized as safe from the potential bubble. This is because the ratio values are still below 2, ranging from 0 to 1.5. Based on these three countries, Malaysia has the most potential for a bubble price to occur. Ease of financing in Malaysia can be one of the factors leading to an increase in housing demand, resulting in a significant increase in the housing price index.

ARIMA Modelling Estimation

The initial step to estimate the ARIMA model is to determine the order of the initial model to be estimated based on the plots of ACF and PACF. The following are the estimation results for house prices in Indonesia, Malaysia, and Singapore.

Indonesia



	AC	PAC	Q-Stat	Prob
1	-0.494	-0.494	20.718	0.000
2	0.009	-0.310	20.725	0.000
3	-0.015	-0.237	20.746	0.000
4	-0.016	-0.217	20.769	0.000
5	0.025	-0.163	20.825	0.001
6	0.009	-0.110	20.832	0.002
7	-0.013	-0.095	20.846	0.004
8	0.001	-0.078	20.846	0.008
9	-0.017	-0.093	20.875	0.013
10	0.013	-0.081	20.891	0.022
11	0.002	-0.069	20.892	0.035
12	0.054	0.036	21.181	0.048
13	-0.118	-0.094	22.573	0.047
14	0.129	0.041	24.249	0.043
15	-0.060	0.036	24.625	0.055
16	-0.070	-0.099	25.136	0.067
17	0.078	-0.059	25.779	0.079
18	0.070	0.106	26.313	0.093
19	-0.211	-0.169	31.191	0.038
20	0.139	-0.115	33.328	0.031

Figure 5. Plot ACF and PACF for estimating HPI Indonesia

Table 2. Estimation Value for ARIMA Modelling of HPI Indonesia

Parameter	**ARIMA (1,2,0)**	**ARIMA (0,2,1)**	**ARIMA (1,2,1)**
	ϕ_{11}= -0.487946 (0.0000)*	θ_{11}= -1.000000 (0.9995)	ϕ_{11}= 0.072329 θ_{11}= -1.000000 (0,7378;0,9995)
Keterangan	Signifikan	Tidak Signifikan	Tidak Signifikan

Based on Figure 4 above, the ACF and PACF plots decrease significantly and approach zero at lag 1, indicating several alternative models that can be used to estimate Indonesia's house price data. The alternative models are ARIMA (1,2,0), ARIMA (0,2,1), and ARIMA (1,2,1). The estimation results for these three ARIMA models can be found in Table 2. The diagnostic results in Table 2 show that the ARIMA (1,2,0) model has a Prob. A value less than α (5%), while the ARIMA (0,2,1) and ARIMA (1,2,1) models have Prob. Values greater than α (5%). Thus, it can be concluded that the ARIMA (1,2,0) model is suitable for estimating Indonesia's HPI. The selection of the best model can be made by looking at the AIC R^2_{adj}.

Table 3. Criteria Best Model for HPI Indonesia

Model	***AIC***	$\boldsymbol{R^2_{adj}}$
ARIMA (1,2,0)	**5.789379**	**0.224584**

In Table 3, it can be seen that the AIC and R^2_{adj} values for the ARIMA model (1,2,0) are 5.789379 and 0.224584, or 22.4%.

Malaysia

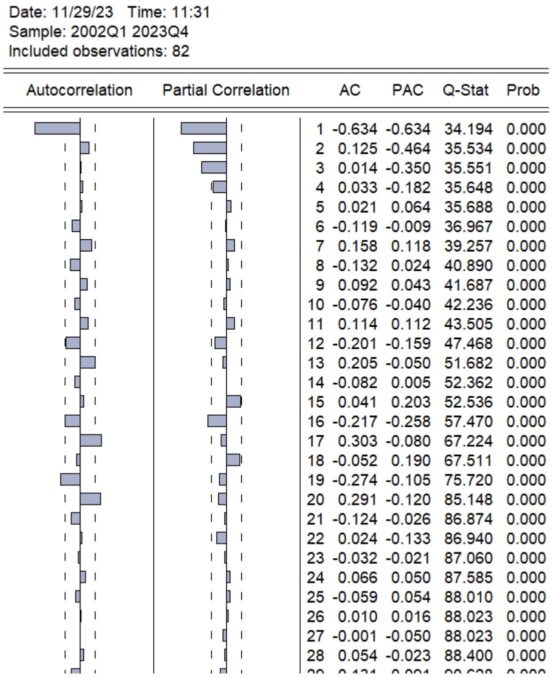


Figure 6. Plot ACF and PACF for Estimating HPI Malaysia

Table 4. Estimation Value for ARIMA Modelling of HPI Indonesia

Parameter	**ARIMA (1,2,0)**	**ARIMA (0,2,1)**	**ARMA (1,2,1)**
	ϕ_{11}= -0.633021 (0.0000) *	θ_{11}= -0.854076 (0.0000) *	ϕ_{11}= -0.395763 θ_{11}= -0.748894 (0.0000;0.0000) *
Keterangan	Signifikan	Signifikan	Signifikan

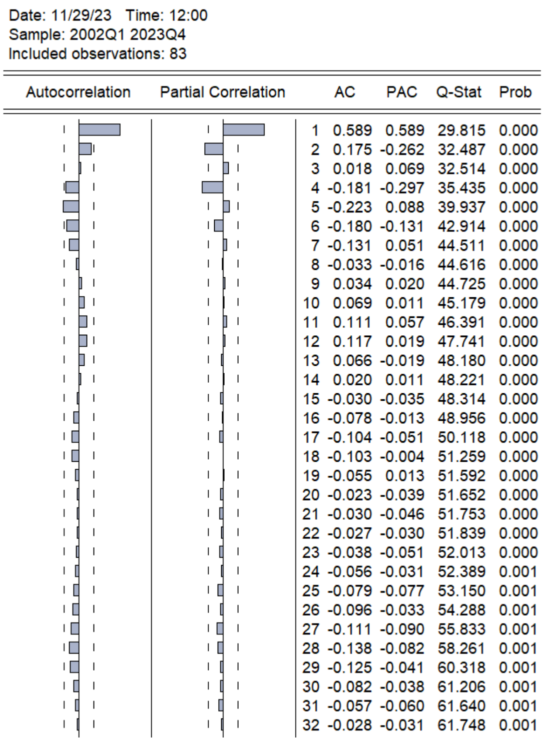
Based on Figure 5 above, the ACF and PACF plots decrease significantly and approach zero at lag 1, indicating several alternative models that can be used to estimate Malaysia's house price data. The alternative models are ARIMA (1,2,0), ARIMA (0,2,1), and ARIMA (1,2,1). The estimation results for these three ARIMA models can be found in Table 2. The diagnostic results in Table 2 show that the ARIMA (1,2,0), ARIMA (0,2,1), and ARIMA (1,2,1) models all have Prob. Values less than α (5%). Thus, it can be concluded that the ARIMA (1,2,0), ARIMA (0,2,1), and ARIMA (1,2,1) models are suitable for estimating Malaysia's house prices. The selection of the best model can be made by looking at the AIC value and R^2_{adj}.

Table 5. Criteria Best Model for HPI Malaysia

Model	*AIC*	R^2_{adj}
ARIMA (1,2,0)	4.531494	0.391221
ARIMA (0,2,1)	4.265132	0.538079
ARIMA (1,2,1)	**4.159116**	**0.590382**

In Table 5, the AIC and R^2_{adj} values for each alternative model are shown. The ARIMA (1,2,1) model has a smaller AIC value compared to other alternative models. The ARIMA (1,2,1) model also has a larger R^2_{adj} value compared to other alternative models, specifically 0.590382 or 59%. Thus, it can be concluded that the ARIMA (1,2,1) model is the best model for estimating Malaysia's house price data.

Singapore


Date: 11/29/23 Time: 12:00
Sample: 2002Q1 2023Q4
Included observations: 83

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.589	0.589	29.815	0.000
		2	0.175	-0.262	32.487	0.000
		3	0.018	0.069	32.514	0.000
		4	-0.181	-0.297	35.435	0.000
		5	-0.223	0.088	39.937	0.000
		6	-0.180	-0.131	42.914	0.000
		7	-0.131	0.051	44.511	0.000
		8	-0.033	-0.016	44.616	0.000
		9	0.034	0.020	44.725	0.000
		10	0.069	0.011	45.179	0.000
		11	0.111	0.057	46.391	0.000
		12	0.117	0.019	47.741	0.000
		13	0.066	-0.019	48.180	0.000
		14	0.020	0.011	48.221	0.000
		15	-0.030	-0.035	48.314	0.000
		16	-0.078	-0.013	48.956	0.000
		17	-0.104	-0.051	50.118	0.000
		18	-0.103	-0.004	51.259	0.000
		19	-0.055	0.013	51.592	0.000
		20	-0.023	-0.039	51.652	0.000
		21	-0.030	-0.046	51.753	0.000
		22	-0.027	-0.030	51.839	0.000
		23	-0.038	-0.051	52.013	0.000
		24	-0.056	-0.031	52.389	0.001
		25	-0.079	-0.077	53.150	0.001
		26	-0.096	-0.033	54.288	0.001
		27	-0.111	-0.090	55.833	0.001
		28	-0.138	-0.082	58.261	0.001
		29	-0.125	-0.041	60.318	0.001
		30	-0.082	-0.038	61.206	0.001
		31	-0.057	-0.060	61.640	0.001
		32	-0.028	-0.031	61.748	0.001

Figure 7. Plot ACF and PACF for Estimating HPI Singapore

Table 6. Estimation Value for ARIMA Modelling of HPI Singapore

Parameter	**ARIMA (1,1,0)**	**ARIMA (0,1,1)**	**ARMA (1,1,1)**
	ϕ_{11}= 0.583533 (0.0000)*	θ_{11}= 0.764190 (0.0000)*	ϕ_{11}= 0.170744 θ_{11}= 0.683160 (0.1083;0.0000)
Keterangan	Signifikan	Signifikan	Tidak Signifikan

Based on Figure 6 above, it can be observed that the ACF and PACF plots significantly drop toward zero at lag 1. Therefore, there are several alternative models that can be used to estimate Singapore's house price data. The alternative models include ARIMA (1,1,0), ARIMA (0,1,1), and ARIMA (1,1,1). The estimation results for these three ARIMA models can be found in Table 2. The diagnostic results in Table 6 show that the ARIMA (1,2,0) model and the ARIMA (0,2,1) model have Prob. Values less than α (5%). On the other hand, the ARIMA (1,1,1) model has a Prob. Value greater than α (5%). Thus, it can be concluded that the ARIMA (1,1,0) and ARIMA (0,1,1) models are suitable for estimating Singapore's house prices. The best model selection can be made by considering the AIC and R^2_{adj}.

Table 7. Criteria Best Model for HPI Singapore

Model	***AIC***	$\boldsymbol{R^2_{adj}}$
ARIMA (1,1,0)	5.180519	0.331261
ARIMA (0,1,1)	**5.060225**	**0.410338**

In Table 7, the AIC and R^2_{adj} values for each alternative model are presented. The ARIMA (0,1,1) model has a lower AIC value compared to the ARIMA (1,1,0) model. Additionally, the ARIMA (0,1,1) model has a higher value compared to the ARIMA (1,1,0) model, with a value of 0.410388 or 41%. Therefore, it can be concluded that the ARIMA (0,1,1) model is the best model for estimating Singapore's house price data.

House Price Forecasting

Table 8. Forecasting Value for HPI

	Indonesia	Malaysia	Singapore
2023Q1	228.5768	211.2239	188.5015
2023Q2	229.6268	213.4312	190.0244
2023Q3	230.6656	215.6516	191.2859
2023Q4	231.6930	217.8849	192.5473

Table 9. Forecasting from Best Model

Country	RMSE	MAE	MAPE
Indonesia	22.18677	18.56822	10.15012
Malaysia	12.36893	10.61025	8.338572
Singapore	14.20654	12.74178	10.41347

In Table 8, the forecasting values for the three countries, namely Indonesia, Malaysia, and Singapore, in the 4th quarter of 2023 are presented. The forecasting values generated based on the best-estimated models for each country show positive values. Positive values indicate an increasing trend in house prices in the 4th quarter of 2023. The forecasted House Price Index for Indonesia, Malaysia, and Singapore in the 4th quarter of 2023 is projected to be 231.69, 217.88, and 192.5, respectively.

5. Conclusions

Houses are commodities used to fulfill the basic human need for shelter. The shift in the motivation for homeownership from merely meeting needs to being an investment instrument has led to an increase in housing demand over each period. Observations indicate that the trend in house prices in Malaysia and Singapore continues to rise each year. In contrast to these two countries, house prices in Indonesia exhibit fluctuating phases in their movements. This study reveals that Malaysia has the highest potential for a surge in house prices. This is evident from the housing bubble ratio nearing the small bubble criteria (2). The highest value of Malaysia's housing bubble ratio is 1.94 in the 2nd quarter of 2020. Based on ARIMA modeling, the best models to estimate house prices in Indonesia, Malaysia, and Singapore are ARIMA (1,2,0), ARIMA (1,2,1), and ARIMA (0,1,1). Forecasting results show that the House Price Index for Indonesia, Malaysia, and Singapore in the 4th quarter of 2023 is projected to be 231.69, 217.88, and 192.5, respectively.

The increasing housing bubble ratio in each country should be a special concern for the government as policymakers. A high housing bubble ratio will eventually burst and can trigger an economic crisis. Countries that have experienced economic crises due to a bubble price include the United States in 2008. Governments, along with scientists, should continue to conduct studies on price control. Factors that trigger high volatility in asset prices need to be examined, and appropriate economic policies need to be implemented to control them. So far, easy credit, massive capital mobility between countries, and shifts in consumer perceptions can be suspected as significant factors contributing to the rise in asset prices, especially houses.

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