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Modelling the Drivers of Housing Price using Autoregressive Distributed Lag – Error Correction Model (ARDL-ECM) in Indonesia

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Abstract
This study aims to design a model tand to estimate the effect of market fundamentals (macroeconomic drivers) on housing prices in Indonesia. The identification of macroeconomic drivers helps the government utilize these macroeconomic indicators to control housing prices in accordance with the current situation. Therefore, the contribution of this study is to analyse how is the housing price in Indonesia. The analytical tool used in this study is the Autoregressive Distributed Lag-Error Correction Model (ARDL-ECM). The variables used in this study are the residential housing price index, real loan interest rates, and the unemployment rate with the observation period starting in the first quarter of 2010 - fourth quarter of 2019. The process of establishing the ARDL-ECM was carried out through a series of tests on research data. Based on the ARDL-ECM estimation results, it was found that in the short-term real loan interest rates had a negative and significant effect on housing prices, while in the long-term real loan interest rates and unemployment rates had a negative and significant effect on housing prices. These results indicate that real interest rates and unemployment rates as macroeconomic drivers can affect housing prices so that they can be utilized by policy makers, specifically through monetary policy (interest rates) and fiscal policy (unemployment rate).

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Introduction

The housing sector has a very critical role in the economy of a country. Housing is one of the government's focuses in an effort to encourage national growth. Based on Gross Domestic

Product data by the Central Statistics Agency (2020) at the real estate and construction sectors have contributed around 13% of Indonesia's GDP in recent years. For most Indonesians, the house is a significant source of wealth (the most considerable investment in society). The housing market has a very important role in the transmission of monetary policy, the transmission mechanism of monetary policy can be reached through the credit channel and the asset price channel. Changes in interest rates influenced by the BI rate will affect the housing sector in terms of demand. The increase in demand for housing will encourage the construction sector which has a significant contribution to Indonesia's GDP. Therefore, through this mechanism the ultimate goal of monetary policy can be achieved, namely the real sector (GDP) and inflation.

An adequate amount of housing stock and development can facilitate labor mobility in an economy and help the economy adjust to shocks. This makes the housing sector one of the sectors that is able to absorb a large number of workers and has a multiplier effect because the housing sector has many derivative sectors and related sectors. Therefore, the real estate sector has a significant influence to attract and encourage the development of other economic sectors.

Some countries such as the United States, Britain, France, and Australia consider that the housing sector has a very critical role in the economy because the house as an asset dominates household wealth in these countries. In Indonesia, the same thing happens, this is reflected in the investment pattern that tends to fall on the choice of land or property assets because they are considered to have a lower risk. Based on this, the housing sector is believed to be able to become a benchmark for economic growth in these countries. Ozmen, Kalafacilar, and Yilmaz (2019) argue that the housing sector is not only related to the real sector through construction, but is also closely related to the financial sector, so it is very important to ensure a “healthy” housing sector as one of the conditions for financial stability considering several crises The monetary sector starts from the housing sector. The importance of the housing sector is also emphasized by Mohan et al. (2019), they assert that housing prices can reflect local/domestic economic conditions. The economy and the housing sector have an interrelated relationship as global economic conditions and national business cycles affect the local housing sector. In addition, understanding the causes (factors) that influence housing price developments is very important when assessing macroeconomic policies and financial stability issues (Asal 2017).

Housing prices, which are influenced by various economic factors, have implications for housing prices as an indicator of monetary policy making in several economies in the world. Al-Masum and Lee (2018) argue that the extent to which market fundamentals are able to explain housing prices provides policy makers with information and insight into the need to issue monetary policy. Bjonland and Jacobsen (2010) find that in Norway, Sweden, and also the UK, the role of housing prices in the monetary transmission mechanism is increasing. In Indonesia

itself, at the end of 2019 the sluggish housing sector in recent years—one of which was indicated by the declining demand for Home Ownership Loans (KPR) and Apartment Ownership Loans (KPA) which finally prompted Bank Indonesia as the monetary policy authority to lower the benchmark interest rate, and it is not enough that in early December 2019 the Loan to Value easing policy is expected to encourage the sluggish housing sector.

Research by Chi-Wei et al. (2017) prove empirical results showing that housing prices affect Gross Domestic Product (GDP), especially in the eastern region and in most provinces in the central region of China. The rapid industrialization and urbanization of the east and the low-cost advantages of the central region are driving housing investment and significantly impacting GDP. In Indonesia, the percentage change in GDP and the house price index shows a relationship. Previous research related to factors that affect housing prices is still focused and underscores the role of the housing price index as an indicator of price increases or inflation (besides the consumer price index). The rapid and high rate of housing prices can indicate the occurrence of a crisis (housing bubble), it is still very rare for research to try to identify the factors that influence housing prices to avoid the risks arising from the declining rate of housing prices themselves. The decline in housing prices has macroeconomic risks such as falling household wealth which can reduce consumer demand and economic growth.

The rate of falling housing prices will also cause property developers to reduce their production so that many jobs are lost in the real estate and construction sectors leading to increased unemployment and a decrease in the number of housing transactions. Another risk that can arise is that fewer and fewer houses are built so that there will be less and less housing supplies and can even threaten housing supplies in the long term. This shows that problems can arise not only when the growth rate of housing prices is too fast and high, but when the rate of housing price growth is too slow and low can also indicate a sluggish economy.

The potential for problems arising from too high and too low growth in housing prices has implications for Bank Indonesia's role as the financial authority to control housing prices. Currently the most frequently used tool to control housing prices is monetary policy by changing the benchmark interest rate or tightening and easing Loan to Value.

Housing as an important component in the economy has the potential to cause problems as indicated by prices. Rapid and high price growth indicates a potential for housing bubbles, while a slow and low rate of price growth indicates a sluggish economy. Housing prices must always be in a reasonable growth movement. One implication is that understanding the causes of housing price movements is very important. One of the causes of housing price movements is market fundamentals, so there is a question of what market fundamental factors (macroeconomic drivers) can explain housing prices in Indonesia in the short and long term?

The purpose of this study is to estimate the effect of market fundamentals (macroeconomic drivers) on housing prices in Indonesia in the short and long term. With the identification of macroeconomic drivers, the government can take advantage of macroeconomic indicators to control housing prices in accordance with the current situation. For example, when housing prices are too high, the government may seek to adjust the influential macroeconomic drivers in order to lower housing prices. The time frame also has implications for the use of macroeconomic drivers in policies related to housing price controls.

The contribution of this research is to provide an overview of the macro econometric modeling of housing prices in Indonesia caused by market fundamentals (macroeconomic drivers). The ARDL-ECM model makes it possible to estimate the effect of the relationship between variables that affect demand, especially the variables that drive macroeconomics in both the short and long term. The data used in this study has a slow growth trend which is different from previous research which always uses fast growth trend data so that it can prove whether with different trends the variables produce the same or different effects.

Literature Review

According to Wyatt (2013), the concept of demand for property (real properties) is quite different from other commodities (especially personal properties). Properties have unique characteristics because one property with another may not be the same because the site cannot move (immovable). This also implies that if property prices fall relative to other factors of production, demand will increase. If the productivity of the property or the price of the resulting commodity increases then the demand for all quantities of land and hence the rent offered will rise. On the supply side, the situation is a bit more different. In the market for a conventional factor of production or final product, the supply curve will slope upward, but the supply of all property or land is completely (perfect) inelastic and cannot be increased in response to higher demand the only response is higher prices. In addition, property has unique characteristics, namely durability, durable housing developments make the numbers continue to accumulate and new developments only add a little to the number of existing houses. This implies that the supply of new housing has a negligible (not significant) effect on prices and therefore property prices are solely determined by demand.

Based on several previous studies discussing housing price modeling, this study uses several macroeconomic variables that affect housing prices in terms of demand. Real loan interest rates are one of the most frequently used variables in housing price modeling (Claussen, 2013; Li and Chand, 2013; Miregi and Obere, 2014; Asal, 2017; Al-Masum and Lee, 2018; Sivitanides, 2018; Mohan et al., 2019). Houses are one of the commodities that have high prices so that the majority of financing is done in the form of mortgages (KPR). This has an impact on

the interest rate which is one of the main considerations for consumers in making mortgages. High interest rates will tend to make consumers delay mortgages, thereby reducing the demand for housing.

The unemployment rate as one of the variables in housing price modeling has been carried out previously by (Abelson et al., 2005; Al-Masum and Lee, 2018; Miller et al., 2011). All argue that a high unemployment rate will reduce housing prices, this happens because a high unemployment rate indicates a weakening of the economy so that people tend not to have purchasing power for housing.

Method

Data is one of the most important aspects in a study. Data is an input that can affect research results in addition to analytical tools. The use of appropriate data can ensure the validity and reliability of a study. This study uses secondary data. The type of data used is time series data with a period of 10 years from 2010 to 2019 and the data used is quarterly data. The time frame selection was based on the fact that in 2008-2009 there was a subprime mortgage crisis and in 2020 there was a COVID-19 pandemic crisis. To avoid the impact of shocks, the data used in this study was when the economic condition was stable. The data used in this study were obtained from the Central Statistics Agency, Bank Indonesia, the Financial Services Authority.

Residential Property Price Index (IHPR) data is used to obtain information on residential property developments, both in the current quarter and forecasts for the next quarter. The IHPR data is the only data available that can proxy the variable housing prices in Indonesia. Real loan interest rate (RRM) data is used to proxy the interest rate used by banks in providing loans, real loan interest rates are calculated by subtracting loan interest rates with inflation. The unemployment rate (UNEMP) is the percentage of the workforce who is unemployed, this data is used to proxy the community's capacity in terms of the economy.

Based on the variables used, this study uses time series data. Time series data is one type of data that is very often used in economic analysis because of the features and characteristics of time series data that are able to show trends, shocks, movements and relationships with sluggishness of the data itself. In analyzing time series data, economists or researchers are often faced with problems in choosing the right method so that research using design and modeling time series data is very important to ensure the method used can meet the assumptions that need to be met.

Time series data has unique properties or characters. These traits and characters make the time series data tend to experience a spurious regression. Insukindro (1991) explains that in accordance with the development of cointegration theory and time series data analysis methods

in the formation of econometric models, a linear regression can be considered inaccurate if it does not pass the stationarity and/or cointegration test. Therefore, stationarity becomes one of the most important aspects in time series data analysis. When stationarity is ignored, this will usually have an impact on the R2 value of the relationship between the two variables which becomes very high even though these two variables have no theoretical relationship. Modeling in time series data is selected and used according to the data used.

This study uses the ECM approach. ECM is a multivariate time series model that is used for data on variables that have a long-term stochastic trend, or often known as cointegration. The problem is that when the regression is carried out by ignoring stationarity, a spurious regression problem arises. Thomas (1997) explains that ECM is one solution to the imprecise regression problem. For example, there is a long-run equation as follows:

$$Y_t = \beta_0 + \beta_1 X_t \tag{1}$$

When Y is at its equilibrium value with respect to X, then equation (1) holds. In fact, economic systems are very rarely in equilibrium, so when Y is at a value different from its equilibrium, the difference between the right and left sides of equation (1) measures the extent to which disequilibrium exists in both variables.

$$DE = Y_t - \beta_0 - \beta_1 X_t \tag{2}$$

The equation (2) can be referred to as a disequilibrium error, if this value is zero then X and Y are at the equilibrium point. When Y is at a value different from its equilibrium, for example it is not only affected by X_t but also affected by X_{t-1} and Y_{t-1} because Y_t takes time to react to changes that occur in X_t.

$$Y_t = \delta_0 + \delta_1 X_t + \delta_2 X_{t-1} + \mu Y_{t-1} + \vartheta_t \tag{3}$$

The problem in estimating equation (3) is that there is no economic content because equation (3) only describes the lag distance from X_t and Y_t. Another problem in equation (3) is when the variable X_t and Y_t is not stationary, then a spurious regression occurs. To deal with the two problems above, the ECM concept is applied.

$$Y_t - Y_{t-1} = \delta_0 + \delta_1 X_t + \delta_2 X_{t-1} - (1-\mu) Y_{t-1} + \vartheta_t \tag{4}$$

$$\Delta Y_t = \delta_0 + \delta_1 X_t - \delta_1 X_{t-1} + \delta_2 X_{t-1} - (1-\mu) Y_{t-1} + \vartheta_t \tag{5}$$

$$\Delta Y_t = \delta_0 + \delta_1 \Delta X_t - \lambda (Y_{t-1} - \beta_0 - \beta_1 X_t) + \vartheta_t \tag{6}$$

Equation (5) is the ECM where the change of Y depends on the change in X and on the equilibrium adjustment in the previous period. ECM simply requires stationary data on the first difference or I (1) when the observed variables are cointegrated, the variables are not spurious.

In formulating a model to explain housing prices, basically this study uses a classical framework of demand and supply where prices are determined by the interaction between demand and supply. But based on the literature, especially on the housing market, the supply aspect has no significant effect on prices, so housing prices are influenced only by demand, the demand and supply functions of housing as follows.

$$D_t = f(P_t, RRM_t, UNEMP_t) \quad (7)$$

$$S_t = f(P_t) \quad (8)$$

Where D_t is demand for housing at time t; S_t is the supply of housing at time t; P_t is the housing price at time t; RRM_t is the real loan interest rate at time t; and $UNEMP_t$ is the unemployment rate at time t. By equating demand with supply and solving the price equation, the general form equation can be written as follows.

$$P_t = f(RRM_t, UNEMP_t) \quad (9)$$

Based on equation (8), the analysis is carried out to estimate the model specifications using the Error Correction Model (ECM). The ECM specification is derived from equation (9). Desired housing price (desired housing price=P_t^*) influenced by real loan interest rates (RRM) and unemployment rates (UNEMP), if expressed in a long run or equilibrium relationship, the equation is as follows.

$$P_t^* = \beta_0 + \beta_1 RRM_t + \beta_2 UNEMP_t + \varepsilon_t \quad (10)$$

ECM estimates not only long-term but short-term effects, so the short-run equation must include the lags of each variable and re-parameterize to:

$$\Delta P_t = \delta_0 + \delta_1 \Delta RRM_t + \delta_2 \Delta UNEMP_t - \lambda(P - \beta_0 - \beta_1 RRM - \beta_2 UNEMP)_{t-1} + \vartheta_t \quad (11)$$

Equation (10) shows a short-term relationship or imbalance which includes P, RRM and UNEMP values and their lags. Equation (11) explains that the current housing price changes (ΔP_t) affected by changes in real interest rates (ΔRRM_t) and unemployment rate ($\Delta UNEMP_t$), and the previous period error correction component. Based on the equation test (11) the results did not meet the specifications of the ECM model because the error correction term in equation

(11) was not significant, then the alternative modeling, namely ARDL-ECM was carried out using equation (12).

$$\Delta P_t = \delta_0 + \delta_1 \Delta RRM_t + \delta_2 \Delta UNEMP_t + \delta_3 RRM_{t-1} + \delta_4 UNEMP_{t-1} + \delta_5 \Delta ECT_{t-1} + \vartheta_t \qquad (12)$$

Result and Discussion

Before proceeding to the estimation of the time series model to identify and measure the influence of the main market fundamentals (macroeconomic drivers) on housing prices in Indonesia, a stationarity test for the dependent and independent variables was carried out. This is necessary to avoid the spurious regression problem. The spurious regression results in misleading OLS estimates and t-statistics which seem to indicate that the independent variable has a statistically significant effect on the dependent variable when in fact it does not. To test the stationarity of the variables used in the model, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were carried out. The test results are presented in Table 1.

Table 1. Stationarity Test Results with ADF and PP

Variables	ADF (level)	PP (level)	Variables	ADF (1st diff)	PP (1st diff)
IHPR (P)	-1.663	-1.223	DIHPR (P)	-2.932*	-2.932*
RRM	-2.561	-2.478	DRRM	-4.93***	-3.888***
UNEMP	-2.711*	-0.799	DUNEMP	-3.120**	-3.650***

*Critical Value *=10% **=5% ***=1%*

As shown in Table 1, all tested variables were not stationary at the level (except UNEMP with ADF test significant 10%). On the other hand, in the first difference all variables are stationary. Based on the two tests that have been carried out, all data are stationary in the first difference. If the variables in the first difference, which are stationary, are regressed, then the spurious regression does not occur. The next step is cointegration test. Cointegration shows a long-term relationship between variables. In the context of cointegration theory, the results of the stationarity test as carried out above are the first step of the cointegration test using the two-step procedure of Engle and Granger.

A variable is said to be cointegrated when individually the variables are stationary at the first difference I (1) but when combined these variables form a linear combination that is stationary at level I (0). In Engle and Granger's two-step procedure method, the first thing to do is to regress on equation (9) which is the long-term equation in this study. This regression will produce a residual. This residual was tested using ADF to determine the presence of a unit root. The variables are said to be cointegrated when the residual is stationary at level I (0).

The residual result in equation (10) is named error correction term (ECT01). ECT01 shows that the residuals show that the average of the data looks constant (no trend), then the

standard deviation of the data is constant, and there is no seasonal movement. The results of the ADF test on ECT show a t-statistic of -1.993737, meaning that ECT01 is stationary at the level with a critical value of 5%. So, it can be concluded that the variables used are cointegrated, therefore short-term analysis can be carried out to estimate the short-term relationship between market fundamentals (macroeconomic drivers) and housing prices.

After knowing the existence of cointegration, the ECM in equation (11) can be regressed. Unfortunately, the results of the regression equation (11) do not meet the specifications because ECT01 is not significant. The alternative model used in this research is ARDL-ECM. The empirical results of equation (11) can be seen in Table 2.

Table 2. ARDL-ECM Empirical Results

Variable	**Result**	
DRRM	Coefficient -1.449	
	t-statistic	-2.797***
DUNEMP	Coefficient -2.287	
	t-statistic	-1.423
ECT02(-1)	Coefficient -0.054	
	t-statistic	-2.578***
RRM(-1)	Coefficient -0.758	
	t-statistic	-4.595***
UNEMP(-1)	Coefficient -1.857	
	t-statistic	-2.363**
Konstanta (C)	27.933	
	t-statistic	3.503***

*Critical Value *=10% **=5% ***=1%*

In Table 2 it can be seen that ECT02(-1) is negative and significant indicating that the ARDL-ECM model is valid and has a significant effect in both the short and long term. The regression in equation (12) produces a residual which is tested by unit root with ADF and PP. The residual results in equation (12) show that the average of the data looks constant (no trend), then the standard deviation of the data is constant, and there is no seasonal movement. The results of the ADF test on this residual show a t-statistic of -4.965 and the results of the PP residual test show a t-statistic of -4.851, meaning that the residual from equation (12) is stationary with a critical value of 1%.

Based on the test results above, it can be concluded that the ARDL-ECM in this study was spared from blunt regression. In addition, Thomas (1997) explains that the stationary on the residuals of the model can meet the assumptions related to disturbance. The assumptions in question are: (1) $E(\varepsilon_t)=0$ for all i; (2) $\text{Var}(\varepsilon_t)=E(\varepsilon_i^2)=\sigma^2=$ constant for all i; (3) $Cov(\varepsilon_i, \varepsilon_j) = E(\varepsilon_i, \varepsilon_j) = 0$ for all $i \neq j$. assumption (1) implies that the residuals are evenly distributed around the regression line so that the mean is 0. Assumption (2) implies that the variance of the residuals is constant. Assumption (3) implies that the covariance between the two residuals is

equal to 0. When these three assumptions are met (indicated by stationary residuals) it is expected that ARDL-ECM in this study avoids the problems of heteroscedasticity and serial correlation (autocorrelation).

The estimated coefficient of real loan interest rates is negative and affects housing prices significantly in both the short and long term. This implies that lower interest rates will make house prices increase. The sign of the coefficient of the unemployment rate is negative but not significant in the short term, meaning that this empirical result does not show strong enough evidence regarding the effect of the unemployment rate on housing prices in the short term. However, in the long run the unemployment rate has a significant negative effect on housing prices.

Based on empirical results, in the short term the unemployment rate has no effect on housing prices, but a decrease in the real interest rate by 1% will increase the rate of housing prices by 1.44%. The effect in the long term is calculated as follows:

$$0 = 27.933 - 0.0542(IHPR - RRM - UNEMP) - 0.758RRM - 1.857UNEMP \quad (13)$$

$$0.0542IHPR = 27.933 + 0.0542RRM + 0.0542UNEMP - 0.758RRM - 1.857UNEMP \quad (14)$$

$$IHPR = \frac{27.933}{0.0542} \frac{-0.758 + 0.0542}{0.0542} RRM \frac{-1.857 + 0.0542}{0.0542} UNEMP \quad (15)$$

$$IHPR = 515.369 - 12{,}985RRM - 33.261UNEMP \quad (16)$$

The calculation above is an implication of the situation where in the long run when the equilibrium position is reached, the equilibrium error is equal to zero. In the long run, a 1% decrease in real lending rates will increase housing prices by 12.985%, and a 1% decrease in the unemployment rate will increase housing prices by 33.261%. The ECT02 coefficient value of 0.0542 means that the difference between housing prices and the balance value is 5.4% which will be adjusted from the previous period.

Conclusion

ARDL-ECM is considered the best model because it meets the specifications for estimating the effect of real loan interest rates and unemployment rates on housing prices compared to ECM. Based on the empirical results of ARDL-ECM estimation, real loan interest rates have a negative effect on housing prices in the short and long term. Then, the unemployment rate has a negative and significant effect on housing prices in the long run but not significant in the short term. The contribution of this study is that housing prices in Indonesia are driven by two macroeconomic drivers, namely real loan interest rates and unemployment rates. Policymakers

can take advantage of these two macroeconomic drivers to adjust housing prices according to the situation at hand. Real lending rates can be lowered by lowering the BI rate. On the other hand, the unemployment rate can be lowered by issuing policies that create jobs. Suggestions for further research is that it is better to determine the model after the time series data is collected considering that time series data, especially related to property, is very difficult to obtain in Indonesia and modeling requires various specification design processes that need to be met.

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