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The implication of loan-to-value ratio on credit housing demand in Indonesia

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ABSTRACT: Housing is one of the basic needs in people's lives. Most people purchase a house or houses through a mortgage program. This encourages the Indonesian government to set the down payment based on the Loan-to-Value (LTV) ratio. This study aims to analyze the implication of the LTV ratio and other effects on housing demand. This study uses secondary data on a monthly basis between March 2012 and December 2017. Based on the results of estimation using the dynamic model Error-Correction Model–Engle Granger (ECM-EG), this study finds that in the short-term period, credit housing demand is influenced by income. The influence of mortgage rates and population also affect credit housing demand in the long term but are not statistically significant. However, housing price, income, and LTV ratio are found to have a statistically significant effect on credit housing demand in the long-term period. The theory of demand being influenced by high prices does not apply to housing demand. Therefore, the implications of the LTV ratio as a financial construct to control housing demand in the housing market is best observed in the long-term period. In addition, there are other factors that affect the demand for housing on credit which need to be considered.

Keywords: Housing demand, mortgage loan, ECM-EG, LTV

1 INTRODUCTION AND POLICY BACKGROUND

Housing is one of the main human needs. The large demand for housing along with population growth and people's financial capability make housing prices increase rapidly. However, home ownership has recently not only intended to meet the basic needs of housing, but has also become an attractive investment alternative. The rapid growth of housing prices is the reason for the purchase of housing, with the two motives that are consumption and investment (Arrondel et al., 2010).

Housing is one of the largest purchases for the community. This makes the purchase of housing credit sensitive. In line with Smith and Smith (2004), people purchase housing for both consumption and investment payoff. According to Figure 1, the purchase of housing credit is very common and widely done within the community.[1]

The purchase of housing credit certainly has considerable risks. As an example, the crisis that occurred in the United States in 2008 was caused by the distribution of sub-prime mortgages. Housing loans were given to all people, with either good or bad credit scores, and as a result the debtors have defaulted. The large number of housing units liquidated by banks for credit failure resulted in an oversupply in the housing market at that time. Lehman Brothers Holdings was one of the sub-prime lenders that had an enormous influence on the housing market in the United States. Lehman Brothers and other sub-prime lenders went bankrupt because the sale of liquidated houses had been unable to cover the losses on

1. Bank Indonesia as Central Bank of Indonesia conducted a residential property pricing survey, published quarterly beginning in 2002, which showed the majority of people use a mortgage program.

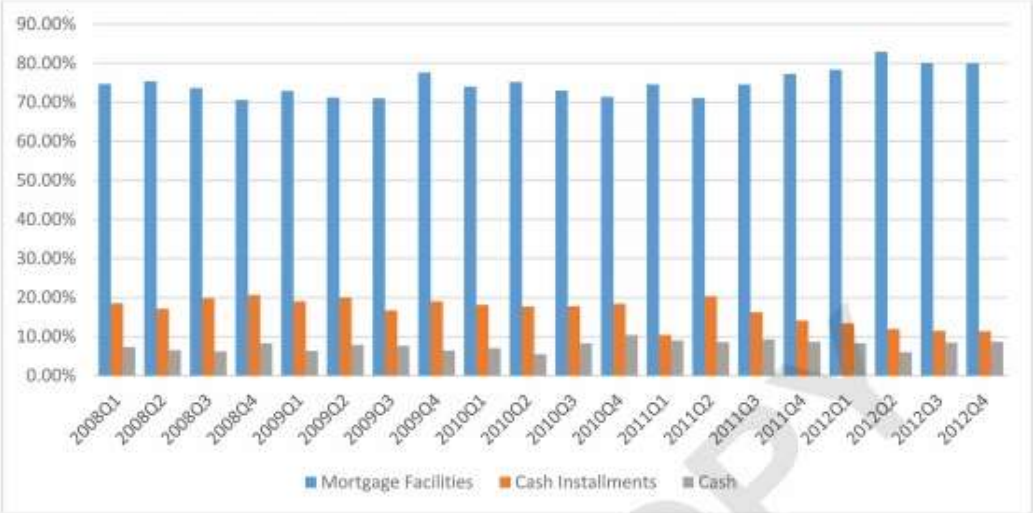

Figure 1. Sources of home financing. (Source: Bank Indonesia).

the debtor's default. This became one of the causes of the world financial crisis as the US economy deteriorated, and the US stock index fell drastically. This crisis demonstrates that the housing market has an influence on monetary policy. In addition, housing as a monetary transmission plays an important part in the economy (Demary, 2009). Moreover, the relationship between property prices and the amount of credit consumption of banking becomes an indicator of the health of a country's economy (Bunda & Ca'Zorzi, 2009).

The pattern of dualistic motive in housing purchase by the community encourages the government to regulate the housing market on monetary lines. Policies are made not only regarding the interest rate applied, but also about the credit advances submitted by communities in fulfilling these needs through Loan-to-Value (LTV) ratio. That this property characteristic is sensitive to credit is one of the reasons for a government to control the housing market through the LTV mechanism. Implementation of an LTV policy is expected to fit the property cycle of boom market, recession, and recovery.

Mishkin (2007a) and Wadud et al. (2012) mention that the direct monetary policy transmission comes from: (i) capital utilization cost; (ii) interest rate effect on expected housing price rises in the future; (iii) housing supply. Meanwhile the, indirect monetary policy transmission through; (i) the standar wealth effects on housing; (ii) the increase of credit balance affects consumption expenditures; (iii) the amount of mortgage loan on housing demand. On the basis of Figure 1, a low mortgage rate will cause the demand for home loans to increase, and then housing prices will increase as the price of land for housing and other housing facilities also increases. However, a credit channel can only work very well when there is financial stress (Hendricks & Kempa, 2009).

2 LITERATURE REVIEW

2.1 *Housing demand*

Demand occurs when there is a willingness and ability of buyers in the market (Turner, 1991). According to Turner, the obstacles that limit demand are low purchasing power and/or the expensive price of goods and services. Eckert (1990) mentioned that the factors that affect the housing market demand are economic, social, governmental, and environmental.

According to McKenzie and Betts (2006), housing demand should be studied from two points of view, the first being the total demand or the number of housing units that are clearly required in the market, while the second point of view is that of housing composition, such as unit size, location, condition, and whether the units are planned to be sold to

consumers or are only for lease. This argument accords with Koutsoyiannis (1982), who stated that home consumption is a long-term consumption, and thus everyone will think about future benefits.

2.2 *Loan-to-value policy*

Loan-to-value is one of the government's policies that can fulfill two tasks simultaneously, first as an economic stimulus and second as the fulfillment of dwelling needs. As one of the property sectors, housing is a leading sector in economic recovery. Therefore, it is expected to have a spillover impact on other sectors such as construction, industry, and mining, as well as services. LTV easing includes two things: decreasing payouts of down payment, and tiering for first housing, second housing, and so on.

On March 15, 2012 Bank Indonesia issued Circular Letter of Bank Indonesia No. 14/10/DPNP on loan-to-value ratio in order to increase caution by banks that provide payment services, mortgages or car loan services. Bank Indonesia regulates the limitation of credit granting. Based on Bank Indonesia's research results, and also considering that Indonesia still lacks available housing, the LTV policy therefore also aims to facilitate the government program in fulfilling the housing needs of the community.

In connection with this research, Rahal (2016) conducted a study using the Vector Auto-Regression (VAR) method of quarterly and monthly data of housing market datasets for eight Organisation for Economic Co-operation and Development (OECD) countries, showing that unconventional monetary policy can reduce real interest rates, reduce the cost of housing users, and therefore increase demand for housing and housing prices. Correspondingly, Xiao (2013) used the standard analysis of Evans and Honkapohja (2001) by using a log-linear proxy with the VAR method.

2.3 *Mortgage loan*

Credit is one of the sources of income for banks (Kasmir, 2010). Credit is classified into productive, consumptive, and trade credit. Credit that is intended to provide financing is called productive credit, whereas consumptive credit is used for personal consumption, financing or business entities, such as mortgages.

The prime lending interest rate is the basis for determining the interest rate conducted by each bank, and is divided into four types, namely (i) corporate credit; (ii) retail credit; (iii) micro credit; (iv) consumer credit. Consumer credit is divided into two, namely mortgage and non-mortgage. According to Utama (2012), the transmission of monetary policy can be seen from the influence of changes in interest rate that impact on real Gross Domestic Product (GDP) and inflation.

Muellbauer (2007) analyzed multi-country data and argues that credit liberalization contributes to the wealth effect that is caused by the appreciation in housing prices. Wadud et al. (2012) explained the influence of monetary policy on the housing market in Australia. The research method used was the Structural Vector Auto-Regression (SVAR) model. The study resulted in a contractionary monetary policy that significantly decreased housing activity. However, housing prices are not only affected by the monetary policy itself. The number of housing units and housing prices have a significant relationship to the housing offer, house demand, and other factors.

3 DATA

As indicated in Section 1, this research seeks to understand the impact of government policy on housing demand, especially from the perspective of mortgage programs. The effects on credit housing demand, besides that of the applied loan-to-value ratio, are prime lending rate on housing, income, residential property price index, and population. This study uses the dynamic model of Error-Correction Model–Engle Granger (ECM-EG) and

uses secondary data on a monthly basis between March 2012 and December 2017. Despite the fact that not every variable can be found directly, due to both the definition of residential property and data collection methodologies, we attempt to harmonize data used in the estimation. One key insight to consider is that a series is available only in annual and quarterly frequency, and so we convert the data using linear interpolation to construct a monthly representation.

All of the data in this research is real data. Thus, if the data is not presented as real data, we divide it by the consumer price index. The monthly series for real GDP and the housing price index are interpolated with linear interpolation from quarterly representation. Real GDP data represents income, and the housing price index represents housing price. Meanwhile, the population's data is interpolated from annual data. For monthly mortgage rate series, we obtain the data from the average mortgage rate of every bank that has a mortgage program.

4 METHODOLOGY

Proposed as an alternative model, error-correction models–Engle Granger is chosen for this macroeconomic research. This study refers to the research of Lim and Nugraheni (2017), which had a primary research focus that used ECM-EG to explore the implications of loan-to-value ratio and other effects on credit housing demand.

4.1 *Model specification*

The analysis with statistical approach uses ECM-EG to capture the dynamics of credit housing demand, facing adjustment in LTV ratio, and other effects. The selection of independent variables in this research used constructs from Rahal (2016), Lim and Nugraheni (2017), and Eichholtz and Lindenthal (2014). Some adjustments were made to accommodate Indonesian data features. In order to understand better the dynamics of credit housing demand relations, the ECM will present short- and long-term analysis in this study.

In determining the impact of monetary policy on the housing market we adapt the model from Tsatsaronis and Zhu (2004), Andrews (2010), and Utama (2012). The short-term housing represents macroprudential policy as the loan-to-value ratio. The analysis of monthly data will be presented to provide a general impact of loan-to-value ratio on people's credit housing demand. The analysis continues with a statistical approach using ECM-EG to capture the dynamics of the housing cycle facing adjustments in the LTV ratio (three times adjustment after loan-to-value has been applied).

Firstly, we conduct an MWD test to determine the function of the empirical model with either log-linear or linear data. MWD test is one of method to choose the model function between a linear regression model or a log-linear regression model in empirical analysis. As a result, we determined to use log-linear data. Following the ECM-EG approach, unit root tests are used to indicate stationary data. The ECM provides an advantage in the form of extensive long-run and short-run time series analysis. The assumption made by the ECM model is that the market is not always in balance and alignment with the conditions that occur. For this reason, we estimate this model with lag lengths for the short run and long run.

4.2 *Estimation and identification strategy*

The ECM-EG method can be used after we consider the data stationarity using the MWD test. As our finding, the integration test is performed to find the data stationarity by looking at the degree of integration value. After the integration test is conducted we should have a co-integration test, which aims to determine what model can be used in the long run with the same stationary degree (Engle & Granger, 1987). Engle and Granger stated that if there's co-integration in the variables, then the dynamic model of ECM-EG can be used. As in

Section 2, we assume that the loan-to-value ratio has a time lag on housing demand; meanwhile, there are other factors that have an influence on credit housing demand.

Statistically, this study used integration tests known as Augmented Dickey–Fuller (ADF) tests for all of the variables. Thus, the formulations are:

$$DX_t = a_0 + a_1 BX_t + \sum_{i=1}^{k} b_i B^1 DX_t \quad (1)$$

$$DX_t = c_0 + c_0 T + c_2 BX_t + \sum_{i=1}^{k} b_i B^1 \, DX_t \quad (2)$$

The model used in this study can be expressed in the ECM model as follows. The first ECM-EG equation for the short term is:

$$D(LNCR)_t = \alpha_1 D(P)_t + \alpha_2 D(LNGDP)_t + \alpha_3 D(LNPOP)_t + \alpha_4 D(LTV)_t + \alpha_5 D(MR)_t + \alpha_6 (ECT) + \mu_t \quad (3)$$

The equation for ECM-EG in the long term is:

$$LNCR_t = \beta_0 + \beta_1 P + \beta_2 LNGDP_t + \beta_3 LNPOP_t + \beta_4 LTV_t + \beta_5 MR_t \quad (4)$$

5 DISCUSSION

The total of mortgage loan requested by the community in period 2012M03 to 2017M12 shows an increasing trend. This indicates that housing demand has tended to increase since the implementation of the loan-to-value ratio. In Figure 2, there are three circles that show that there is a change of LTV ratio. In the sample period it can be seen that the mortgages demanded by the community show a small fluctuation when there is a policy adjustment.

Based on the result of the analysis presented in Table 1, only the mortgage rate variable is stationary, with a significance level of 1%. Other variables besides mortgage rate are not significant at the level degree, and thus are tested in terms of the integration degree. After testing the integration degree, the result shows that all variables can be stationary at the first difference level. The probability value of the unit root test of all variables at the first difference is less than 1% significance, or all variables have an ADF value that is less than the

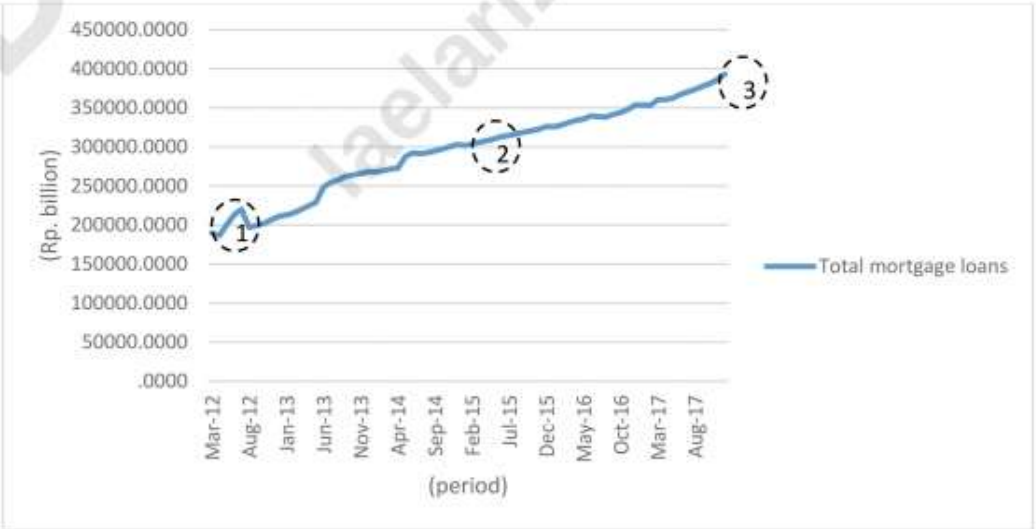

Figure 2. Total mortgage loans. (Source: Bank Indonesia, 2017).

Table 1. Unit roots test.

	Level		First difference	
Variable	ADF	Prob.	ADF	Prob.
LNCR	–1.55085	0.5021	–8.310759	0.0000***
P	–1.5807	0.4870	–8.072911	0.0000***
LNGDP	–1.27312	0.6376	–8.26619	0.0000***
LNPOP	–1.79667	0.3792	–9.613563	0.0000***
LTV	–1.31962	0.6160	–8.382172	0.0000***
MR	–4.28691	0.0010***	–8.281015	0.0000***

Notes: *** Significant in α: 5%, df = 64.

Table 2. Error-correction model–Engle Granger test results (Source: Author's calculation, 2018).

		Short-term			Long-term		
Variable	Hypothesis	Coefficient	*t*-value	Prob.	Coefficient	*t*-value	Prob.
C	–				–1.41498	–0.51213	0.6103
P	–	0.178844	1.487000	0.1420	0.251702[a]	2.69816	0.0089[b]
LNGDP	+	0.728241[a]	4.282296	0.0001[b]	0.840699[a]	6.637562	0.0000[b]
LNPOP	+	2.251108[a]	0.927470	0.3572	0.001368[a]	0.00227	0.9982
LTV	+	0.001273[a]	0.729972	0.4681	0.005294[a]	2.944432	0.0045[b]
MR	–	0.00275[a]	–0.765955	0.4466	–0.00395	–0.56585	0.5735
E(–1)	–	–0.21261	–2.53587	0.0137			
R-squared		0.715601			0.980801		
Adjusted R-squared		0.693029			0.979301		
F-statistic					653.8874		
Prop (F-statistic)					0.000000		

Notes: a. The coefficient is the same as the hypothesis; b. Significant in α: 5%, df = 64.

critical ADF value at 5% significance. Table 2 shows the short-term and long-term ECM-EG test results.

The value of residual coefficient (ECT) as listed in Table 2 is –0.212608, and is significant at 5% confidence degree because the value of t-count is –2.535867 (< –1.66901). It is in accordance with the ECM-EG criteria that the result must be negative and significant. Thus, this research model is valid and has fulfilled the ECT requirement. Therefore, this research has passed the entire classical assumption test. The ECT value indicates that the dependent variable has adjusted the independent variable with one lag, or approximately 21% of the long-term and short-term mismatches that can be corrected.

The estimation result using ECM-EG for the short-term equation shows that in the short term, the government's loan-to-value ratio has a positive effect on the amount of mortgage loans demanded by the community. Meanwhile, in the long term, the loan-to-value ratio has a positive and significant effect on the amount of mortgage loans demanded by the community. The result of this research is in accordance with Rahal (2016), who states that the policy of loan-to-value is one of the monetary policies that can affect housing demand through housing prices, real interest rates, and the cost of home use. Similarly, Lewis and Mizen (2000) state that monetary policy affects the output and inflation in a country that responds to the banking sector, finance, and real sectors.

The short-term equation for mortgage rate effect using ECM-EG shows that it affects the amount of mortgage loans demanded by the community. Similarly, in the long term, the mortgage rate has an effect on the amount of mortgage loans demanded by the community. The hypothesis in this research predicts a negative relationship between the mortgage rate

and the amount of mortgage loans demanded by the community; after the ECM-EG test is done, it turns out that the result obtained supports this hypothesis. This means that if the mortgage rate is increased by 1%, then the mortgage loans distributed to the community will decrease. The result of the analysis of the relationship between mortgage rate and the amount of credit distributed to the community supports the research conducted by Bunda and Ca'Zorzi (2009), which finds that the interest rate and credit channels are the influential channels in the real sector. A similar statement is also made by Koutsoyiannis (1982, p. 186), that the community will allocate the income consumed in a certain period with consideration of the prevailing interest rate. The mortgage rate assigned to the community using mortgage-backed housing facilities in Indonesia is enacted to a flat interest rate only for a few years at the beginning. In general, the community will pay interest on a flat interest rate system in the first two to five years, while in the following years they will use a floating interest rate.

The early hypothesis in this research predicts that there is a negative correlation between residential property price index and the number of mortgage loans demanded by the community. After the ECM-EG test is conducted it turns out that the results obtained do support this hypothesis. That means that if the value of residential property price index increases for one denomination then the amount of mortgage loans demanded by the community will increase, indicating a positive correlation.

Price is included in the category of economic factors in the housing market, as Eckert (1990) stated that factors affecting housing market demand include economic factors, social factors, governmental factors, and environmental factors. Eckert's research is also supported by Takatz's research (2012), which states that there is a significant effect on housing prices with housing demand. Meanwhile, Powell and Stringham (2008) stated that expensive housing prices or tend to increase steadily is not only because of a high demand, but also because of the intrinsic value of expensive land, regulations on the housing market, population density, attitude, home models, construction cost, building approval processes, and existing laws in the area. It also refers to determining the market value of housing that has various characteristics, one of them being scarcity.

Real GDP is a factor that greatly affects people's demand for housing credit consumption because real GDP has a positive and statistically significant effect in the long term and short term. A similar statement is expressed by Arrondel et al. (2010); that a person will allocate his income to buy a house as consumer goods but also as an investment asset. Meanwhile, Sabari (1994) states that housing has four dimensions, namely location, housing, life cycle, and income. The income dimension itself is related to the amount of a person's income multiplied by the duration of their stay in a city.

The estimation result using ECM-EG for the short-term equation shows that in the short term the rate of population growth has a positive effect on the amount of mortgage loans demanded by the community. This result is similar to the long-term estimation result; that the rate of population growth has a positive effect on the amount of mortgage loans demanded by the community. This supports Takatz's (2012) research, which shows that population growth has an influence on housing demand. McKenzie and Betts (2006) state that one of the most important considerations in housing demand is the number of housing units needed in the market, which are constrained by the development of the population, especially in terms of those who are already of working age.

6 CONCLUSION

Factors that influence people's motivation to make a home purchase on credit in the short term are a coefficient of real GDP, which represents a person's income to make a purchase, and it has a significant effect. An increased real GDP will effect an increasing pattern of home consumption. Meanwhile, the factors that significantly influence people's motivation to purchase housing on credit in the long term are the residential property price index, real gross domestic product, and loan-to-value ratio.

The government's effort is not only aimed at the fulfillment of there being dwellings for the community, especially for those who are impoverished citizens, but also at the country's stimulus. By providing the monetary policy of loan-to-value, the government can run two tasks simultaneously, which are as an economic stimulus and the fulfillment of housing needs. By relaxing macroprudential policy, it is expected to encourage the property demand. LTV easing includes two things: decreasing payouts of down payments and tiering for first housing, second housing, and so on.

7 RECOMMENDATION

In controlling the housing market from the housing demand side, most people use a mortgage that is not only based on the established LTV ratio, but where there are also other factors to be considered. Increased housing demand is also followed by rising housing prices, due to the increasing scarcity of vacant land or land that can be used to build houses. Thus, the government needs to re-examine the LTV, not only as one of the monetary policy transmissions but also as an economic stimulus.

Property market conditions, especially housing in various regions, have different characteristics. Some areas of Indonesia, such as Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi) as a megapolitan city, have different market behaviors compared to other regions such as Sumatera, Kalimantan, and other regions that have a lot of smaller cities. This obviously should be the government's consideration in establishing a general policy.

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APPENDIX 1

Analysis Error-Correction Model

a. The first equation:

$$LNCR_t = \beta_0 + \beta_1 LTV_t + \beta_2 MR_t + \beta_3 P_t + \beta_4 LNPDB_t + \beta_5 LNPENDUDUK_t + e_t \quad (a)$$

b. Error-correction model formulation:

$$Ct^{de} = b_1 (LNCR_t - LNCR_{t*})^2 + b_2 ((1\text{-}B)\, LNCR_t - f_t (1\text{-}B)Zt)^2 \quad (b)$$

c. Minimized quadratic cost single-period function:

$$LNCR_t = bLNCR_{t*} + (1\text{-}B)B\, LNCR + (1\text{-}B)f_t(1\text{-}B)Z_t \quad (c)$$

d. Equation substitution:

$$LNCR_t = b(\alpha_0 + \alpha_1 LTV_t + \alpha_2 MR_t + \alpha_3 P_t + \alpha_4 LNGDP_t + \alpha_5 LNPOP_t + (1\text{-}b)\, f_t\, (1\text{-}B)$$
$$(LTV, MR, P, LNGDP, LNPOP) \quad (d)$$

as follows:

$$LNCR_t = \alpha_0\, b + \alpha_1\, b\, LTV_t + \alpha_2\, b\, MR_t + \alpha_3\, b\, P_t + \alpha_4\, b\, LNGDP_t + \alpha_5\, b\, LNPOP_t + (1-b)\, LNCR_t - LNCR_{t-1} + (1-b)\, f_t\,(LTV_t - LTV_{t-1}, MR_t - MR_{t-1}, P_t - P_{t-1}, LNGDP_t - LNGDP_{t-1}, LNPOP_t - LNPOP_{t-1}) \quad (e)$$

$$LNCR_t = \alpha_0\, b + \alpha_1\, b\, LTV_t + \alpha_2\, b\, MR_t + \alpha_3\, b\, P_t + \alpha_4\, b\, LNGDP_t + \alpha_5\, b\, LNPOP_t + (1-b)\, LNCR_t - LNCR_{t-1} + (1-b)\, f_1\,(LTV_t - LTV_{t-1}) + (1-b)\, f_2\,(MR_t - MR_{t-1}) + (1-b)\, f_3\,(P_t - P_{t-1}) + (1-b)\, f_4\,(LNGDP_t - LNGDP_{t-1}) + (1-b)\, f_5\,(LNPOP_t - LNPOP_{t-1}) \quad (f)$$

$$LNCR_t = \alpha_0\, b + \alpha_1\, b\, LTV_t + \alpha_2\, b\, MR_t + \alpha_3\, b\, P_t + \alpha_4\, b\, LNGDP_t + \alpha_5\, b\, LNPOP_t + (1-b)\, LNCR_t - LNCR_{t-1} + (1-b)\, f_1\,(LTV_t - (1-b)\, f_1\, LTV_{t-1}) + (1-b)\, f_2\,(MR_t - (1-b)\, f_2\, MR_{t-1}) + (1-b)\, f_3\,(P_t - (1-b)\, f_3\, P_{t-1}) + (1-b)\, f_4\,(LNGDP_t - (1-b)\, f_4\, LNGDP_{t-1}) + (1-b)\, f_5\,(LNPOP_t - (1-b)\, f_5\, LNPOP_{t-1}) \quad (g)$$

$$LNCR_t = \alpha_0\, b + (\alpha_1\, b + (1-b)\, f_1)\, LTV_t + (\alpha_2\, b + (1-b)\, f_2)\, MR_t + (\alpha_3\, b + (1-b)\, f_3)\, P_t + (\alpha_4\, b + (1-b)\, f_4)\, LNGDP_t + (\alpha_5\, b + (1-b)\, f_5)\, LNPOP_t - (1-b)\, f_1\, LTV_{t-1} - (1-b)\, f_2\, MR_{t-1} - (1-b)\, f_3\, P_{t-1} - (1-b)\, f_4\, LNGDP_{t-1} - (1-b)\, f_5\, (LNPOP_{t-1}) \quad (h)$$

or,

$$LNCR_t = c_0 + C_1\, LTV_t + C_2\, MR_t + C_3\, P_t + C_4\, LNGDP_t + C_5\, LNPOP_t + C_6\, LTV_{t-1} + C_7\, MR_{t-1} + C_8\, P_{t-1} + C_9\, LNGDP_{t-1} + C_{10}\, LNPOP_{t-1} \quad (i)$$

with,
$c_0 = \alpha_0\, b$
$c_1 = \alpha_1\, b + (1-b)\, f_1$
$c_2 = \alpha_2\, b + (1-b)\, f_2$
$c_3 = \alpha_3\, b + (1-b)\, f_3$
$c_4 = \alpha_4\, b + (1-b)\, f_4$
$c_5 = \alpha_5\, b + (1-b)\, f_5$
$c_6 = \alpha_6\, b + (1-b)\, f_6$
$c_7 = \alpha_7\, b + (1-b)\, f_7$
$c_8 = \alpha_8\, b + (1-b)\, f_8$
$c_9 = \alpha_9\, b + (1-b)\, f_9$
$c_{10} = \alpha_{10}\, b + (1-b)\, f_{10}$

So, the function for mortgage loan becomes:

$$LNCR_{t-1} = C_1\, LTV_{t-1} + C_2\, MR_{t-1} + C_3\, P_{t-1} + C_4\, LNGDP_{t-1} + C_5\, LNPOP_{t-1} - C_1\, LTV_{t-1} - C_2\, MR_{t-1} - C_3\, P_{t-1} - C_4\, LNGDP_{t-1} - C_5\, LNPOP_{t-1} + C_{11}\, LTV_{t-1} + C_{11}\, MR_{t-1} + C_{11}\, P_{t-1} + C_{11}\, LNGDP_{t-1} + C_{11}\, LNPOP_{t-1} + C_{11}\, LNCR_{t-1} - C_{11}\, LTV_{t-1} - C_{11}\, MR_{t-1} - C_{11}\, P_{t-1} - C_{11}\, LNGDP_{t-1} - C_{11}\, LNPOP_{t-1} - C_{11}\, LTV_{t-1} - C_{11}\, MR_{t-1} - C_{11}\, P_{t-1} - C_{11}\, LNGDP_{t-1} - C_{11}\, LNPOP_{t-1} \quad (j)$$

$$LNCR_t - LNCR_{t-1} = C_0 + C_1\, LTV_t - C_1\, LTV_{t-1} + C_2\, MR_t - C_2\, MR_{t-1} + C_3\, P_t - C_3\, P_{t-1} + C_4\, LNGDP_t - C_4\, LNGDP_{t-1} + C_5\, LNPOP_t - C_5\, LNPOP_{t-1} + C_1\, LTV_{t-1} + C_6\, LTV_{t-1} + C_{11}\, LTV_{t-1} - LTV_{t-1} + C_2\, MR_{t-1} + C_7\, MR_{t-1} + C_{11}\, MR_{t-1} - MR_{t-1} + C_3\, P_t + C_8\, P_{t-1} + C_{11}\, P_{t-1} - P_{t-1} + C_4\, LNGDP_t + C_9\, LNGDP_{t-1} + C_{11}\, LNGDP_t - LNGDP_{t-1} + C_5\, LNPOP_t + C_{10}\, LNPOP_{t-1} + C_{11}\, LNPOP_t - LNPOP_{t-1} + C_{11}\, LTV_{t-1} + C_{11}\, MR_{t-1} + C_{11}\, P_{t-1} + C_{11}\, LNGDP_{t-1} + C_{11}\, LNPOP_{t-1} \quad (k)$$

Then, Equations j and k can be transformed:

$$\begin{aligned} LNCR_t - LNCR_{t-1} = {} & C_0 + C_1 (LTV_t - LTV_{t-1}) + C_2 (MR_t - MR_{t-1}) + C_3 (P_t - P_{t-1}) \\ & + C_4 (LNGDP_t - LNGDP_{t-1}) + C_5 (LNPOP_t - LNPOP_{t-1}) + (C_1 + C_6 \\ & + C_{11} - 1)\, LTV_{t-1} + (C_2 + C_7 + C_{11} - 1)\, MR_{t-1} + (C_3 + C_8 + C_{11} - 1) \\ & P_{t-1} + (C_4 + C_9 + C_{11} - 1)\, LNGDP_{t-1} + (C_5 + C_{10} + C_{11} - 1)\, LNPOP_{t-1} \\ & + (1 - C_{11})\, (LTV_{t-1} + MR_{t-1} + P_{t-1} + LNGDP_{t-1} + LNPOP_{t-1} - LNCR_{t-1}) \end{aligned} \quad (l)$$

or,

$$\begin{aligned} D(LNCR_t) = {} & C_0 + C_1\, D(LTV_t) + C_2\, (MR_t) + C_3\, (P_t) + C_4\, (LNGDP_t) + C_5\, (LNPOP_t) + C_6 \\ & LTV_{t-1} + C_7\, MR_{t-1} + C_8\, P_{t-1} + C_9\, LNGDP_{t-1} + C_{10}\, LNPOP_{t-1} + C_{11}\, (LTV_{t-1} \\ & + MR_{t-1} + P_{t-1} + LNGDP_{t-1} + LNPOP_{t-1} - LNCR_{t-1}) \end{aligned} \quad (m)$$

The model used in this study can be expressed in the ECM model as follows. The ECM-EG equation in the short term is:

$$\begin{aligned} D(LNCR)_t = {} & \alpha_1 D(P)_t + \alpha_2 D(LNGDP)_t + \alpha_3 D(LNPOP)_t + \alpha_4 D(LTV)_t + \alpha_5 D(MR)_t \\ & + \alpha_6 (ECT) + \mu_t \end{aligned} \quad (n)$$

The equation for ECM-EG in the long term is:

$$LNCR_t = \beta_0 + \beta_1\, P + \beta_2\, LNGDP_t + \beta_3\, LNPOP_t + \beta_4\, LTV_t + \beta_5\, MR_t \quad (o)$$

APPENDIX 2

Variable definition.

Denotation	Variable	Note
CR	Total mortgage loans (Credit)	Total value of mortgage loans that people want. The data is the amount of total mortgage loans granted each month.
P	Housing Price	Measure from the averaged aggregated housing price from 16 major cities in Indonesia (for small, medium, and large houses); P is performed on log-linearization.
GDP	Real Gross Domestic Product	Reflects the housing consumption indicated by household income.
POP	Total Population	Population growth to measure the development of housing demand.
LTV	Loan-to-Value Ratio	A regulation set by the government to control down payments and tiering in the housing market.
MR	Short-term Mortgage Rate	Short-term rate for mortgage loans applied by every bank in Indonesia.