Low-Interest Rate Policy and Japanese Housing Market

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Abstract

I investigate the effect of the GHLC's housing loan policy on housing construction in Japan and analyze the positive effects of the GHLC's direct housing loan. I evaluated the GHLC's housing loan policy by employing Vector Auto Regression (VAR) techniques, particularly the impulse response function.

Firstly, I outline the transition of Japanese housing finance, focusing on the role of the GHLC. Secondly, I analyze the extent to which low-interest rate policy by the GHLC, which was responsible for the vast majority of publicly issued housing loans, raised the supply of housing. Thirdly, I check the structural change. In particular, I investigate whether the rate at which new houses were built by lowering the GHLC's interest rate changed in the third quarter of 1999, when the GHLC's budget exceeded the actual value of issued housing loans.

I Introduction

The main objective of the Japanese housing loan policy was to increase the supply of housing and relieve the post-WWII housing shortage, which had arisen until a period of rapid growth, using direct housing loans provided by the Government Housing Loan Corporation (GHLC) (GHLC, 1993). In this paper, I investigate the effect of the GHLC's housing loan policy on housing construction in Japan and analyze the positive effects of the GHLC's direct housing loan.

Firstly, I outline the transition of Japanese housing finance, focusing on the role of the GHLC. Secondly, I analyze the extent to which low-interest rate policy by the GHLC, which was responsible for the vast majority of publicly issued housing loans, raised the supply of housing.

Since the interest rates of GHLC housing loan are then used as policy variables, I verify quantitatively how the development of new housing is affected when the interest rate on GHLC housing loans is lowered that is whether or not the low-interest rate policy of the GHLC prompted the building of more homes. Following this, I investigate whether the rate at which new houses were built by lowering the GHLC's interest rate changed in the third quarter of 1999, when the GHLC's budget exceeded the actual value of issued housing loans.[1)]

1) Value of housing loans refers to total value of money lent for house purchases.

I evaluated the GHLC's housing loan policy by employing Vector Auto Regression (VAR) techniques, particularly the impulse response function. I chose this method for the following reasons: Firstly, by using an empirical model that analyzes house construction using OLS, endogenous variables can be included as explanatory variables and create bias. Secondly, the VAR model is one of the most suitable structures for identifying relationships in the real economy without imposing theoretical constraints.

Before beginning my analysis of the impulse response functions, I performed tests to check for seasonality, stationarity in the data and the existence of cointegration between the variables. I establish that new housing development, the interest rate on GHLC housing loans and the value of GHLC-issued housing loans are non-stationary series with unit roots. In addition, I clarify the nature of the data used in this research and use the variance decomposition technique to check the validity of the conclusions drawn from the analysis of the impulse response function.

A number of authors have investigated the GHLC. Kamoike (1991) presents a theoretical model describing the behavior of households demanding housing and firms supplying housing, and analyzing GHLC loans. However, Kamoike (1991) investigates the effect of GHLC policy on housing prices and rents, rather than on housing construction, and his conclusion remains indeterminate.

Honma et al. (1988) investigate the effect of changes in the GHLC interest rate on housing demand. They estimate the demand function of houses owned by age group, and show that a lowering of the GHLC lending rate reduced the cost of capital and raised housing demand. The difference between Honma et al.'s (1988) work and this study is that Honma et al. do not investigate the effect of the GHLC's interest rate policy on housing construction either directly or quantitatively. Even if housing demand does increase when interest rates are lowered, the effect of this on housing construction depends on the elasticity of the supply curve of housing stock. Moreover, Honma et al. (1988) use data for both 1977 and 1986. Since the purpose of this study is to evaluate the GHLC's policy and examine changes in policy effects after the structural changes within the Japanese housing market had occurred, our periods of estimation differ.

Yoshino and Nakata (2000) show that an increase in the value of public housing loans does stimulate housing investment, and that this effect has declined since the Heisei Recession of 1992. Their conclusion is as follows. Commercial activities can be suppressed by public housing loans, therefore it is desirable that only private financial institutions issue such loans. However, I can interpret their empirical findings by stating that GHLC housing loans still stimulated housing investment in 1988. Unlike Yoshino and Nakata (2000), I adopt the VAR method and the intention of analysis is not only the effect of the value of GHLC-issued loans for housing construction but also the impact of the GHLC interest rate. The estimation period also differs from Yoshino and Nakata (2000) because of this difference in focus.

As demonstrated by the above, this study is the first to verify the effect of changes in the GHLC interest rate for housing construction. I show that the effects changed after the budget came to exceed the actual value of housing loans being granted by the GHLC. In addition, unlike the above studies, this analysis aims to reveal the underlying economic structure from the data. This is the first

study that verifies quantitatively the effects of both the low-interest rate policy and the value of the GHLC's housing loan by employing a VAR model.

To date, few researchers have used VAR analysis to investigate housing policies. Using the impulse response function, Pozdena (1990) demonstrates that deregulation, such as in the removal of interest rate ceilings on deposit rates, weaken the linkage between the interest rate and housing construction in the United States. However, this research does not aim to identify the effect of policies implemented by a public financial institution.

For the proposed privatization of two United States Government-sponsored housing enterprises – Fannie Mae and Freddie Mac – in 2019, the Japanese experience might offer some lessons: (1) The low-interest rate housing loans of the GHLC, which is a government housing loan corporation, contributed to housing construction; (2) We cannot say that securitization of housing loans backed by the Japan Housing Finance Agency (JHFA, the successor of the GHLC), which imitated the securitization model of the above United States Government-sponsored housing enterprises, is successful; and (3) Housing loan business is not so profitable for private financial institutions during periods of low-interest rates.

In Section 2, I provide an outline of the Japanese housing finance system. In Section 3, I specify the objectives and describe the method of analysis employed, identify the model and the data used, and check the properties of the data using unit root tests and cointegration tests, amongst others. In Section 4, I then investigate the impact of the low-interest rate policy of the GHLC on housing construction. Section 5 concludes.

Ⅱ Overview of the Japanese Housing Loan System

In this section I provide an overview of the Japanese housing loan system and note its major transitions. I summarize actual situation of public housing loans and private housing loans in Japan. In addition, I provide an review of the abolition of GHLC as carried out by the Koizumi administration.

1 The Japanese Housing Loan System

The Japanese housing loan system consists of a public housing loan system that is managed by a public institutions and a private housing loan system operated by multiple private financial institutions. The public institutions which issue housing loans are the GHLC and local public agencies, and the private institutions are city banks, local banks and Shinkin banks.

The total value of outstanding housing loans was ¥ 1,878,163 trillion at the end of the 2016 fiscal year, and the total value of new housing loans was ¥ 245,651 trillion (Housing Loan Progress Association, 2018). Table 1 illustrates the transition in the composition ratio of new housing loans as for public and private financial institutions.

According to Table 1, public housing loans accounted for 50% of the total in 1993. This contrasts

Table 1 Transition in the Ratio of New Housing Loan Amount (%)

Fiscal year	1993	1998	2003	2008	2013	2015
Public institutions	49.9	36.1	11.0	5.3	9.6	12.2
GHLC	40.1	30.6	8.7	0.0	0.3	0.2
Direct finance	0.0	0.0	0.0	3.5	9.0	11.6
Loan through securitization						
Local public agency	1.9	1.5	1.4	1.5	0.3	0.4
The rest	7.9	4.0	0.9	0.3	0.1	0.0
Private institutions	50.1	63.9	89.0	94.7	90.4	87.8
Domestic banks (City banks・Local banks・Trust banks・Trust accounts)	33.1	48.8	69.4	75.1	71.7	69.4
Shinkin banks	6.4	7.4	10.2	8.6	8.7	10.0
Labor banks	2.9	4.4	7.0	8.4	7.7	6.6
Others	7.7	3.3	2.4	2.6	2.3	1.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Note: These are figures of housing loans of individuals.
Source: Calculated by the author using data from JHFA (2017) and GHLC (2003).

starkly with ratios around 20% in the United States, the United Kingdom, and Germany in 1996, demonstrating that the public housing loan system is much larger in Japan.

Among public housing loans, the loan value for new housing under the GHLC reached 40% of the total in 1993. At that time, the Japanese Government decided to abolish both direct financing and the GHLC, thereby reducing the JHFA's direct financing of housing loans to zero by 2008. Since this time, the receivables from housing loans financed by the JHFA's securitization project have been gradually increasing (see Table 1).

2 Public Housing Loan

The GHLC was responsible for the vast majority of publicly issued housing loans in Japan (Table 1). Therefore, this subsection provides a history of the GHLC and the succeeding JHFA, as well as specifying their modes of operation.

The GHLC was founded in 1950, according to the plan of the General Head Quarter (GHQ), to issue housing loans and resolve the issue of housing shortages in Japan after WWII (GHLC, 1993). As a result, the GHLC played a major role in expanding the housing supply and improving the quality of housing in Japan during the postwar reconstruction period and the first half of the rapid growth period, while private financial institutions were being urged to supply industrial funding. The GHLC, together with the public housing system and the Japan Housing Corporation (which became the Urban Infrastructure Development Corporation in October 1999) bore responsibility for housing policy in the postwar period.

The GHLC was a part of the Fiscal Investment and Loan Program (Zaisei Tōyūshi) (FILP). The FILP was the system by which the Ministry of Finance collected money from Japanese people in the form of postal savings and pension savings. This money was used to finance special corporations, of which the GHLC was one. The operating interest rate on GHLC-issued loans was lower than the procurement interest rate of the FILP. The difference was covered by the general budget (ippan kaikei) of the Japanese Government.

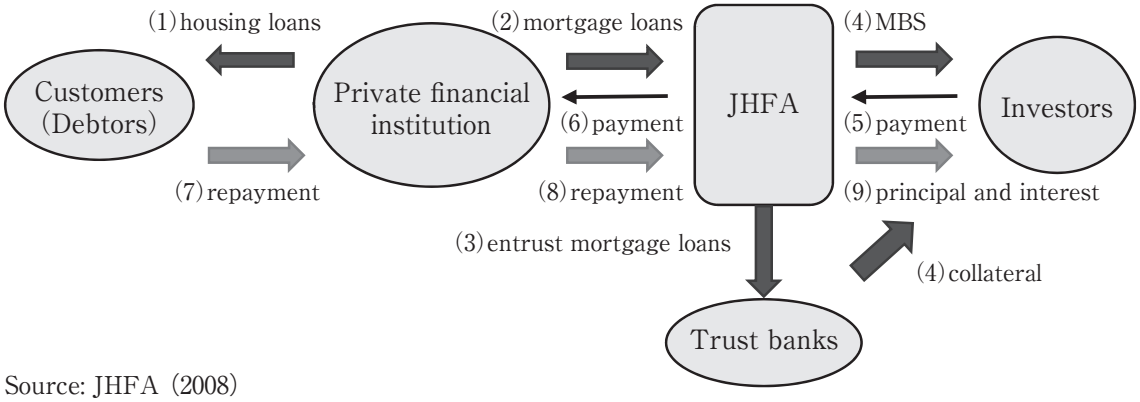
The GHLC contributed to the enlargement of the housing stock in Japan. However, it was abolished as part of the structural reform implemented by the Koizumi administration in 2007 following criticism over its commercial activities and the coverage of its deficit by the general budget. The JHFA took over the institution and began operations of securitizing housing loans.

Securitization was undertaken as follows (see Figure 1):

(1) Private financial institutions make housing loans to customers (debtors) at long-term fixed interest rates.
(2) Private financial institutions sell mortgage loans to the JHFA.
(3) The JHFA entrust these mortgage loans to trust banks for security.
(4) The JHFA issues Mortgage Backed Securities (MBSs) to investors, using mortgage loans as collateral.
(5) The JHFA receives payment for MBSs from investors.
(6) The JHFA pays private financial institutions for mortgage loans with this payment from investors.
(7) Private financial institutions receive repayment (principal and interest) from customers.
(8) Private financial institutions pass these repayments on to the JHFA.
(9) The JHFA pays the principal and interest to investors, as for MBS.

Table 1 shows that the value of purchase receivables obtained through the securitization of mortgage loans (lent by private financial institutions) accounted for 11.6% of the total value of new housing loans in 2015. Housing loans purchased in this way are managed by 327 private institutions

Figure 1 Scheme of Operation for Securitization of Housing Loans



Source: JHFA (2008)

under the name of "Flat 35" (Yasui, 2015).

However, 71.4% of private financial institutions were found not to have experience of securitization and did not consider this necessary. Furthermore, 72.4% of private financial institutions attributed this phenomenon to a lack of knowledge regarding securitization (JHFA (2017)), in other words, the securitization of JHFA-issued loans is not going smoothly.

According to the JHFA (2017), about 80% of private financial institutions are willing to manage housing loans. These private financial institutions point to increases in the value of outstanding loans (73.4%), the enforcement of household transactions (71.3%), and the recent decrease of ratio of the loans to firms (33.2%) as reasons for this attitude. This shows that these institutions want to take on housing loans which allow them to earn long-term profits.

On the other hand, private financial institutions note important points as matters of concern regarding the risks of housing loans. These factors include decreases in margins due to interest rate competition (95.5%), a medium- to long-term deterioration in profitability (60.6%), and housing loan refinancing to other private financial institutions (58.1%) (JHFA, 2017). Yasui (2015) demonstrates that housing loan businesses cannot be profitable in this low-interest environment.

Ⅲ Method of Analysis and Preliminary Tests

In this section, I first outline the method of empirical analysis employed and specify the time-series models estimated. I then describe the data used. As preliminary tests to check the nature of the data used in the VAR analysis, I examine seasonality and stationarity of the data and I also perform the cointegration tests.

I test the effect of a policy variable on housing loan markets. I analyze the effect of the GHLC's interest rate on housing construction. I identify periods when the budget exceeded the actual value of GHLC housing loans and test for structural changes thereafter. assuming that GHLC-issued housing loans become less effective as a policy instrument since then.[2)] During this time, the interest rates of private financial institutions were declining and many GHLC-issued housing loans were being refinanced by private financial institutions as the interest rates on short-term housing loans from these institutions dropped below the GHLC rate.

I analyze the housing loans of individuals because the objective of this investigation is to determine whether this housing loan policy satisfied the housing needs of individuals, and because the majority of GHLC-issued loans were offered to individuals.

I measure housing by unit rather than area in order to consider the housing stock as influenced by housing policy and because the Japanese Government and the GHLC use the number of units to measure housing.

2) The information was obtained from a contact in the housing loan market.

1 The Model

The model developed uses VAR system. In an autoregression (AR) model, the current values of a variable are estimated using its past values. The VAR model is an extension of an AR model with several variables (Yamasawa, 2004).

In general, the equations to be estimated in the VAR model are as follows:

$$X_t = \alpha_x + \sum_{i=1}^{n} \beta_{xi} X_{t-i} + \sum_{i=1}^{n} \gamma_{xi} Y_{t-i} + u_{xt} \tag{1}$$

$$Y_t = \alpha_y + \sum_{i=1}^{n} \beta_{yi} X_{t-i} + \sum_{i=1}^{n} \gamma_{yi} Y_{t-i} + u_{yt} \tag{2}$$

That is, in the estimation of VAR equation systems, the current values of X_t and Y_t are regressed onto lagged values of X_t and Y_t.

According to Yamasawa (2004), much of the research using quarterly data has employed a lag of a year (i.e. n=4). Thus, in this study, I also let n equal 4. I employ a two-variable VAR system, rather than a large VAR system with many variables, in order to only take into account the necessary number of variables for acquiring sufficient degrees of freedom (Yamasawa, 2004), but also because the scarcity of data relating to post-structural change in the Japanese housing market restricts the size of the VAR. Thus, my VAR system is as follows:

$$\begin{aligned} X_t = {} & \alpha_x + \beta_{x1} X_{t-1} + \beta_{x2} X_{t-2} + \beta_{x3} X_{t-3} + \beta_{x4} X_{t-4} \\ & + \gamma_{x1} Y_{t-1} + \gamma_{x2} Y_{t-2} + \gamma_{x3} Y_{t-3} + \gamma_{x4} Y_{t-4} + u_{xt} \end{aligned} \tag{3}$$

$$\begin{aligned} Y_t = {} & \alpha_y + \beta_{y1} X_{t-1} + \beta_{y2} X_{t-2} + \beta_{y3} X_{t-3} + \beta_{y4} X_{t-4} \\ & + \gamma_{y1} Y_{t-1} + \gamma_{y2} Y_{t-2} + \gamma_{y3} Y_{t-3} + \gamma_{y4} Y_{t-4} + u_{yt} \end{aligned} \tag{4}$$

In (3) and (4), X_1 and Y_1 change according to changes in X_0, X_2 and Y_2 change according to the change in X_0, X_1 and Y_1. In this way, a VAR system expresses mutual dependence between the variables. X_t in (3) and Y_t in (4) refer to housing development and the interest rates of GHLC-issued housing loans.

The choice of a VAR model can be explained as follows. By assuming a theoretical model and estimating this model by OLS, with housing construction included as a dependent variable, endogenous variables, such as the interest rate of housing loans, would often be included as explanatory variables. This would undermine the assumptions of OLS regression: that explanatory variables should either be exogenous variables or lagged endogenous variables. Equally, applying OLS to simultaneous equation systems, including housing development as an explanatory variable, produces bias. However, VAR models eliminate these issues, since no distinction is made between endogenous and exogenous variables. Moreover, VAR models are appropriate in this context,

because this study investigates the effect of a shock from one variable to another using impulse response functions. It evaluates the GHLC policy by studying observed effects, rather than by constructing a theoretical model. Thus, VAR models, which capture the relationships between variables without theoretical constraints on equations, are more suitable.

2 The Method of Empirical Analysis

Before applying my VAR model, data processing must be undertaken. Firstly, I test the data for seasonality and compensate for seasonal trends in order to capture broader movements in the housing market. Secondly, I make non-stationary series (with unit roots) stationary before estimating equations and analyzing through a VAR model. To do this, I check for stationarity and difference non-stationary values to make them stationary. Thirdly, I examine the cointegration of series. Since for those that are cointegrated, I have to apply the vector error correction model (VECM) rather than a VAR model.

In this paper, the results of impulse response functions are analyzed. I study the effect of interest rates on new housing development. I use impulse response functions because they show the movements of other variables when a shock (impulse) is experienced by one variable.

The impulse response functions are as follows. Assume that $X_{-1}=X_{-2}=Y_{-1}=Y_{-2}=0$ in (3) and (4) and suppose for simplicity that $\alpha_x=\alpha_y=0$.[3] Considering an impulse of u_{x0}=1 at time 0, such that $X_0=1$ and $Y_0=0$ at time 0. Substituting these into (3) and (4) produces $X_1=\beta_{x1}$ and $Y_1=\beta_{y1}$. Moreover,

$$\begin{aligned} X_2&=\beta_{x1}X_1+\beta_{x2}X_0+\gamma_{x1}Y_1=\beta_{x1}{}^2+\beta_{x2}+\gamma_{x1}\beta_{y1},\\ Y_2&=\beta_{y1}X_1+\beta_{y2}X_0+\gamma_{y1}Y_1=\beta_{x1}\beta_{y1}+\beta_{y2}+\gamma_{y1}\beta_{y1}. \end{aligned} \tag{5}$$

The values can be calculated consecutively. X_0, X_1, X_2, and X_3 and so on are the response functions of X to an impulse to X; Y_0, Y_1, Y_2, Y_3 are response functions of Y to an impulse in X. Usually, the size of an impulse is one standard deviation of an error term.

Unlike the simple comparison of coefficients, impulse response functions have the advantage of incorporating all direct and feedback effects into the model (Pozdena, 1990). For example, considering the change in housing development caused by an impulse to the interest rate of housing loans, the impulse response function first shows a change in housing development and then a change in the interest rate for housing loans caused by this change in housing development, which continues in a feedback loop. In addition, impulse response functions reveal the effect of a change in a variable more explicitly and visually. I also present the impulse response of housing development to a 1% change in the interest rate to show the effect in a more comprehensible way.

I also use variance decomposition to identify the response of one variable to another and identify

3) No important change in the main argument of the study arises from this simplicity.

the proportion of the variation in housing development that can be explained by interest rate changes and the value of GHLC-issued housing loans. I use this method because changes in these proportions suggest a structural change in the housing market (Pozdena, 1990).

3 Data

The study uses quarterly data from the period between 1981 and 2004,[4] as this is the most time-disaggregated data available. I use the standard interest rate (kijunkinri) of the GHLC as the interest rate on GHLC housing loans (RKOUKO). In this study, data on new housing development rather than data on housing investment is used, since the value of housing stock can be misrepresented due to problem in housing valuation when we calculate investment (Pozdena, 1990). The source of the data of new housing development (KOCHAK) is *Monthly Construction Statistics* from Ministry of Land Infrastructure and Transport.

4 Seasonality

I calculate the sample autocorrelation coefficient of each series to check for seasonality. According to Table 2, new housing development (KOCHAK) exhibits annual seasonality. However, no definite patterns are observable in the interest rate on GHLC housing loans (RKOUKO). Moreover, these two series are found to be non-stationary in 3.5. Therefore, I examine the sample autocorrelation coefficient of the first-differenced series.[5] As Table 3 shows, for new housing development (KOCHAK), there are annual (i.e. four-quarter lag) peaks in the sample autocorrelation coefficient of the first-differenced series, while there are no evident annual peaks for the interest rate on GHLC

Table 2 Sample Autocorrelation Coefficient of the Original Data

Lag k	RKOUKO	KOCHAK
1	0.960	0.565
2	0.914	0.391
3	0.872	0.365
4	0.835	0.587
5	0.800	0.222
6	0.765	0.067
7	0.726	0.048
8	0.690	0.280
9	0.652	− 0.010
10	0.614	− 0.137
11	0.583	− 0.112
12	0.552	0.159

4) To make the results of this paper comparable with those of Hirono (1998), the starting point of my data is the same as that in his work.

5) As is shown in Section 3.5, all the series are non-stationary. In such cases I looked at a sample autocorrelation coefficient of the first-differenced series to check seasonality (Wago, 1987).

Table 3 Sample Autocorrelation Coefficient of the First-differenced Series

Lag k	RKOUKO	KOCHAK
1	0.354	− 0.297
2	− 0.072	− 0.174
3	− 0.136	− 0.288
4	− 0.090	0.677
5	0.060	− 0.241
6	0.033	− 0.157
7	− 0.127	− 0.290
8	− 0.061	0.600
9	− 0.006	− 0.188
10	− 0.127	− 0.174
11	− 0.028	− 0.282
12	− 0.123	0.638

housing loans (RKOUKO). Therefore, there is no significant seasonality in the interest rate on GHLC housing loans (RKOUKO) series.

To reach a definite conclusion, I use F-tests in the process of X-12-ARIMA to check for seasonality. The results show that KOCHAK exhibits seasonality, while RKOUKO does not. From these tests, it is clear that new housing development does exhibit seasonality, while the interest rate on GHLC housing loans does not.

5 Stationarity

To check for stationarity, I perform unit root tests known as the Dickey–Fuller (DF) tests. Table 4 shows the results of these tests. For each series, I produce three specifications: Specification 1, where the test regression does not include either a drift or a trend term; Specification 2, where the test regression includes only a drift term; and Specification 3, where the test regression includes both a trend and a drift term.

I adopt the results in which the drift term and the trend term in the test regression of the random walk are significant at the 5% level. That is, I employ Specification 3 if both drift and trend terms are significant at the 5% level, Specification 2 if the drift term is significant but the trend term is not, and Specification 1 when both terms are not significantly different from zero at the 5% level.

According to Table 4, the null hypotheses for new housing development (KOCHAK), and the interest rate of GHLC housing loans (RKOUKO), that the series have unit roots at the 5% level,

Table 4 Unit Root Tests of the Original Series (in the level)

Series	Test statistic	Specification
RKOUKO	− 1.654	1
KOCHAK	− 2.342	2

*Statistically different from zero at the 5% level.

Table 5 Unit Root Tests of the Fourth-differenced Series

Series	Test statistic	Specification
RKOUKO	− 3.194*	1
KOCHAK	− 2.778*	1

*Statistically different from zero at the 5% level.

cannot be rejected. These series are therefore non-stationary at level.

Since KOCHAK, and RKOUKO are non-stationary at level, and since KOCHAK exhibits annual seasonality, I analyze the fourth (annual)-difference of the original data. I then perform unit root tests (DF tests) on this differenced series. Table 5 indicates that, the fourth-differenced series of KOCHAK and RKOUKO are all stationary.

6 Cointegration Tests

Next, I run Johansen cointegration tests to identify whether there is cointegration between variables. For the VAR model, I make the series stationary by differencing if the series has a unit root. In addition, I include an error correction term in the model if variables display cointegration according to Yamasawa and Nakano (1998).

The results of the cointegration tests show that there is no cointegration between new housing development and the interest rate of GHLC housing loans (Tables 6 and 7). These results are confirmed not only by the trace tests, but also by the maximum eigenvalue tests. The inclusion of an error correction term is therefore not required in any VAR model.

Table 6 Trace Test

Series	No. of cointegrations r (the null hypothesis)	Alternative hypothesis	Trace statistic	5% critical value
RKOUKO, KOCHAK	r=0	$r \geq 1$	10.70	25.87

* denotes rejection of the null hypothesis at the 5% level.

Table 7 Maximum Eigenvalue Test

Series	No. of cointegrations r (the null hypothesis)	Alternative hypothesis	Maximum eigenvalue statistic	5% critical value
RKOUKO, KOCHAK	r=0	r=1	8.08	19.39

*denotes rejection of the null hypothesis at the 5% level.

Ⅳ Policy Evaluations

In order to evaluate the housing policy of the GHLC, I present the impulse response functions that show the reaction of housing development (KOCHAK) to changes in the interest rate on GHLC housing loans (RKOUKO), which was a policy variable of the GHLC.[6)]

According to the activities, plans and performance list of GHLC financing agreements (GHLC, 2003), the budget exceeded the actual value of individual housing loans issued by the GHLC in the fiscal year of 2000.[7)] However, since the budget is indicated at the end of the fiscal year, I use the interpolation method to adjust according to quarterly data. The interpolation shows that the budget was surpassed in the third quarter of 1999. Therefore, I separate impulse responses up to the second quarter of 1999, when the budget for GHLC-issued individual housing loans was below the actual value, and since the third quarter of 1999, when the budget surpassed the actual value. The fact that the value of GHLC-issued housing loans was underbudget meant that the GHLC could no longer deliver effective housing loan policies.[8)]

In order to make the KOCHAK and RKOUKO variables stationary, I take fourth-difference of the data, removing the annual seasonality of KOCHAK. I do not seasonally adjust my data using X-12-ARIMA because this method removes the seasonality of the original data by converting to moving averages several times. In this case, even if there is an apparent causal relationship in the original data, there are many occasions in which the causal relationship disappears or a spurious causal relationship could be identified instead (Wago, 1987). In other words, X-12-ARIMA can change the properties of the data.

1 The Impulse Response Function

I first use the impulse response function to investigate the effect of the interest rate on GHLC-issued housing loans on new housing development. Figure 2 shows the response of new house building to a shock in the interest rate (RKOUKO) up to the second quarter of 1999, when the budget for the GHLC individual housing loans was less than the actual value of debt issued. Figure 3 shows the effect of an interest rate shock on housing development since the third quarter of 1999, when the budget for the GHLC individual housing loans exceeded the actual value of loans issued. Figures 2 and 3 indicate the extent to which new housing development changed by a one-standard-

6) Although policy variables of the GHLC include the term of limitation of housing loans, there is no possibility that the GHLC used this as a policy variable to increase or decrease housing starts. Therefore I did not include the term of limitation of housing loans in my analysis.

7) GHLC individual housing loans were the total loan debt issued by the GHLC for building new owner-occupied houses, buying good-quality houses for sale, or for buying houses, condominiums, ready-built houses, reused houses, residential portions of urban inhabitability recovery plans, and urban redevelopment dwellings from the Corporation, according to my interview with GHLC officials.

8) As for the period up to the second quarter of 1999, demand for housing loans surpassed the budget of the GHLC, and the GHLC supplied loans in excess of the budget.

Figure 2 Impulse Response of New Housing Development to a Shock in the Interest Rate of the Housing Loans of the GHLC (−the second quarter of 1999)

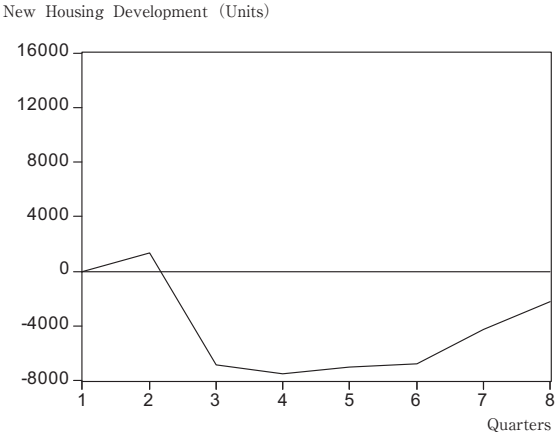
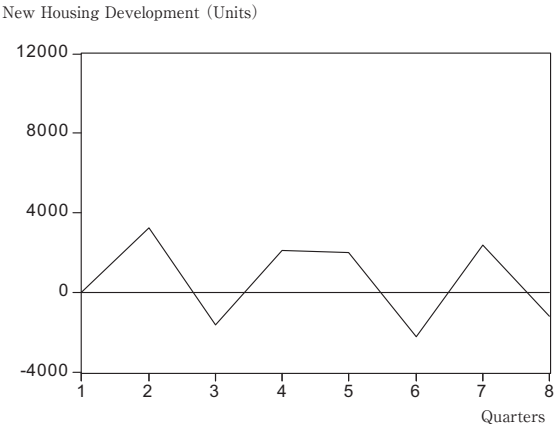


Figure 3 Impulse Response of New Housing Development to a Shock in the Interest Rate of the Housing Loans of the GHLC (the third quarter of 1999−)



deviation (of error term) shock in the GHLC interest rate.[9)]

The horizontal axis of Figure 2 measures the number of quarters following the initial shock. Figure 2 shows the impact on new housing development following the positive shock given in the first quarter. It displays a decrease of approximately 7,000 units over two quarters.[10)]

Figure 2 shows that, up to the second quarter of 1999, a positive shock to the interest rate on

9) In the studies of policy evaluation, variables in the model are often logarithmically transformed and the percentage change in a variable of policy object caused by a 1% change in policy variable is investigated. However, 'the percentage change of interest rate which is already expressed in a percentage' is misleading. Thus, I did not logarithmically transform my series as did Pozdena (1990), who analyzed the effect of the TB rate on housing starts.

10) The method of analysis for Figure 3 is the same as Figure 2.

GHLC housing loans lowered housing development after two quarters. That is, the GHLC would increase new housing development by lowering the interest rate of its housing loans (RKOUKO). However, as shown by Figure 3, the impulse response adopts a zigzag shape, indicating an inconsistent effect of the GHLC interest rate on housing loans (RKOUKO) on new housing development over time.

Table 8 presents the results specified in Figures 2 and 3. In addition, it includes the impulse response of new housing development to a 1% change in the interest rate of GHLC housing loans (RKOUKO), where a 1% change signifies a change in interest rate from 1% to 2%, and not a change in interest rate from 1% to 1.01%. I also include the accumulated impulse response to examine the effect of the policy.

According to Table 8, a positive shock of one standard deviation of the error term of RKOUKO lowered new housing development by 6,770.7 units in six quarters (five quarters after the shock) up to the second quarter of 1999. In other words, a one-standard-deviation decrease in RKOUKO resulted in an increase in new housing development by 6,770.7 units. In short, the low-interest rate policy of the GHLC had a positive effect on new housing development in this period.

For the period since the third quarter of 1999, the effect of the same positive shock to RKOUKO on housing development over the six quarters was a decrease of 2,208.9 units. Thus, the absolute value of response was lower that before the second quarter of 1999. In addition, between one to eight quarters after the shock, the impulse response took both positive and negative values. A 1% decrease in RKOUKO caused an increase in housing development of 26,291.7 units over six quarters up to the second quarter of 1999, whereas since the third quarter of 1999 the absolute value of an impulse response to a 1% decrease in RKOUKO decreased largely to 9,237.4 units. This impulse response took both positive and negative values during the eight quarters following the shock.

The accumulated impulse response up to the second quarter of 1999, as shown in Table 8, shows that a one-standard-deviation decrease in the interest rate of GHLC housing loans increased new housing development by 33,389.2 units over eight quarters. Since the quarterly average of new house constructions was 198,546 units in Japan, this increment in new housing development amounts to

Table 8 Impulse Response of New Housing Development Caused by a Shock to the Interest Rate of the GHLC Housing Loans

Quarters since shock	Impulse response (1 std dev.)		Impulse response (1%)		Accumulated impulse response (1 std dev.)		Accumulated impulse response (1%)	
	—1999Q2	1999Q3—	—1999Q2	1999Q3—	—1999Q2	1999Q3—	—1999Q2	1999Q3—
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	1306.1	3272.2	5071.6	13,683.7	1306.1	3272.2	5071.6	13,683.7
3	− 6874.7	− 1597.7	− 26,695.7	− 6681.3	− 5568.7	1674.5	− 21,624.1	7002.3
4	− 7536.2	2094.4	− 29,264.2	8758.5	− 13,104.9	3768.9	− 50,888.3	15,760.8
5	− 7033.9	2035.7	− 27,314.0	8512.8	− 20,138.8	5804.6	− 78,202.2	24,273.7
6	− 6770.7	− 2208.9	− 26,291.7	− 9237.4	− 26,909.5	3595.7	− 104,493.9	15,036.3
7	− 4285.8	2387.5	− 16,642.5	9984.0	− 31,195.3	5983.2	− 121,136.4	25,020.3
8	− 2193.9	− 1191.2	− 8,519.1	− 4981.5	− 33,389.2	4791.9	− 129,655.5	20,038.9

16.8% of the total. A 1% decrease in the interest rate of housing loans caused a rise in new house building of 129,655.5 units over the eight quarters. As for the period following the third quarter of 1999, a one-standard-deviation decrease in RKOUKO lowered new housing development by 4,791.9 units, and a 1% decrease in RKOUKO reduced new housing development by 20,038.9 units.

From these results, it can be verified that up to the second quarter of 1999, when the budget was lower than the actual value of individual housing loans issued by the GHLC, a policy of lowering the interest rate of GHLC housing loans had a positive effect on housing construction. Since the third quarter of 1999, when the budget exceeded the actual value of GHLC-issued individual housing loans, the effectiveness of any lowering of the interest rate vanished.

These results show that the GHLC succeeded in increasing housing construction through its low-interest-rate policy up to the second quarter of 1999. During this period, the GHLC granted housing loans at a low rate of interest, and there was excess demand for the GHLC housing loans (of $q - q'$, as illustrated in Figure A1 of Appendix). Faced with this excess demand, the GHLC increased the actual value of housing loans granted. Consequently, the actual value eventually exceeded the GHLC's budget. Lowering the interest rate on GHLC housing loans increased the level of demand. Thus, the actual value of housing loans increased and housing construction rose as a result.

Additionally, over the period when the budget exceeded the actual value of housing loans issued by the GHLC (i.e. since the third quarter of 1999), the effect of the GHLC's low-interest-rate policy disappeared. The budget surpassed the actual value of loans because of competition with private financial institutions that were offering three-year housing loans at a lower rate of interest than the GHLC. As a result, an increasing number of consumers preferred the floating-rate housing loans of private financial institutions to the longer-term fixed-rate housing loans of the GHLC. Thus, the lowering of interest rates by the GHLC became largely ineffective.

2 Variance Decomposition

A variance decomposition analysis is conducted to determine the importance of the interest rate on GHLC housing loans (RKOUKO) to changes in new housing development. According to Table 9, up to the second quarter of 1999, 30.2% of the variation in housing development measured at eight quarters was caused by RKOUKO. Since the third quarter of 1999, the effect of RKOUKO declined sharply to 13.5%.

11) Data and analysis in Section 3 and 4 of this paper is from Hirono (2005, 2012). I have added analysis of Japanese housing loan system in Section 2.

Table 9 Variance Decomposition of New Housing Development (%)

	RKOUKO	
Quarters	-1999Q2	1999Q3-
1	4.3	0.1
2	6.3	7.6
3	10.6	6.5
4	15.7	8.3
5	22.1	9.9
6	28.0	11.8
7	30.2	13.1
8	30.4	13.5

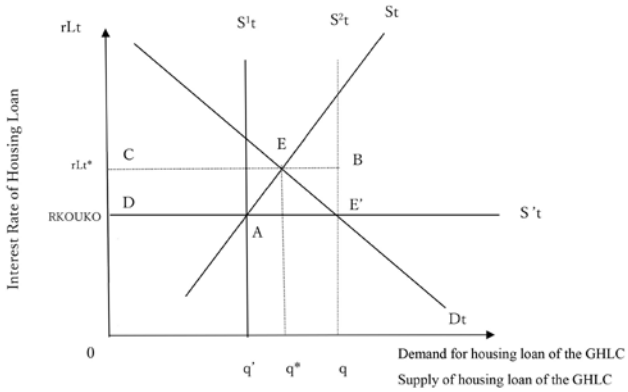
V Conclusion

This analysis finds that the low-interest rate policy has contributed to the level of house building in Japan. A lowering of the interest rate for GHLC housing loans by one standard deviation of the residuals increased new housing development by 6,770.7 units in five quarters. This effect had disappeared in the third quarter of 1999, when the GHLC budget exceeded the actual value of housing loans issued. These results verify that the low-interest rate policy of GHLC contributed to the size of the housing stock in Japan.

Appendix *Housing market when actual value of housing loan of GHLC exceeded the budget*

Here we look at housing market when actual value of housing loan of GHLC exceeded the budget. In Figure A4, Dt is demand for housing loans of GHLC. GHLC made loans at a fixed interest rate RKOUKO. We show the budget of GHLC housing loan by q'. Reflecting that this is the analysis about the period when actual value of housing loan of GHLC exceeded athe budget, RKOUKO was lower than market interest rate, which means that there was excess demand for housing loans at interest rate RKOUKO. To meet this excess demand, GHLC made housing loans (actual value) over the budget till q. The equilibrium was E'.

Figure A1 Low-Interest Rate Housing Loan of GHLC and Housing Loan Market



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