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Analysis of Housing Market Dynamics Considering the Structural Characteristics of Mortgage Interest

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Abstract: Mortgage loan interest rates consists of base interest and spread. In general, the base interest is adjusted by the government for the sustainability of the housing market. On the other hand, spread is determined by market mechanisms. Accordingly, the change pattern of base interest and spread may appear differently depending on the market situation. In the end, the effect of the government's market intervention through interest rate policy may be different than expected. In this respect, the purpose of this paper is to analyze the effects of base interest and spread of the mortgage loan interest rate on the housing market and to derive important policy implications for the sustainability of the housing market. As a result of this study, the ineffectiveness of the government's interest rate policies on the stability of the housing market was confirmed. The market mechanisms had more significant effects on the sustainability of the housing market than artificial political intervention. Further, housing supply policies based on the market mechanism could be more effective than housing demand policies based on interest-rate adjustments.

Keywords: Korean housing market; base interest; spread; housing policy; Fisher–DiPasquale–Wheaton model; vector error correction model

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1. Introduction

Over the past decades, residential property prices in several industrial economies, including the Republic of Korea, have faced extreme fluctuations. Since the mid-1980s, the Republic of Korea's economy has experienced major housing market boom and bust cycles. Spanning 1988: Q1–1991: Q3, the first boom marked an annual average real housing price of approximately 14.2%. This bullish run was then followed by a decade-long bear market that lasted until the economy endured the impact of the Asian currency crisis. The rebound of the economy marked the coming of the second boom; during 2001: Q4–2007: Q4, the real housing prices increased sharply. Since the global financial crisis (GFC) of 2007–2008, the housing sector has exhibited signs of slowdown [1]. Residential investment constitutes a large percentage of the gross domestic product and therefore is key to general business conditions. Furthermore, housing serves the purpose of loan collateral for borrowers. Fluctuations in house values can drastically alter the performance of the leveraged financial institutions. Therefore, the market fluctuations could cause economic vulnerabilities and crises [2]. Because the housing market is an uncertain and competitive market with widespread implications and contributions for the national economy, it requires government intervention through policies and regulations. In particular, housing-price stabilization policies have been the general approach implemented by the Government of the Republic of Korea over the past several decades [3].

The interest rate policy is a representative policy instrument to stabilize the market [4]. The fundamental mechanism of this policy involves increasing the rates and mortgage costs to decrease the housing demand and, consequently, the prices [5]. However, there is no consensus on the relationship between the rates and prices despite the former being one of the most important policy tools influencing the housing price fluctuation [6]. This is due to the structural characteristics of interest rates as well as the complex dynamic relationships between various variables and the housing market [7,8].

The monetary policy of the government influences the housing market through financial markets. In other words, the base interest, one of the policy measures, affects the mortgage loan interest rates. When monetary policy transmission is smoothly implemented, the monetary policy can affect the housing market in a way that it pursues [9,10]. However, the structure of the mortgage loan interest rate consists of the base interest and market spread [8]. Although the government optimizes the base interest to achieve its policy target, the housing market can grow less sensitive to changes in the base interest due to a change in the market spread [11,12]. In the Republic of Korea, base interest continued to rise before the global financial crisis, but real housing prices rose sharply. On the other hand, despite the overall decline in base interest after the global financial crisis, the housing market has not been activated.

Therefore, the analysis of changes in the housing market should be based on the structural characteristics of mortgage loan interest rates, which are crucial factors in the investigation of the effects of monetary policies. Existing research has recognized that changes in the interest rates influence the housing market, and various studies have been conducted to examine this issue [4–6,13]; however, few studies have reflected on the structural characteristics of mortgage loan interest rates.

In this study, the effects of the base interest and spread of the mortgage loan interest rate on the housing market were analyzed through a vector error correction model (VECM). Based on the results, the implications of political intervention for a sustainable market were verified. Data for this analysis were collected from the apartment market of Seoul, which is considered the representative housing market of the Republic of Korea. As for the temporal range of time-series data, January 2002 to December 2008, i.e., before the GFC, was denoted as Period A, and January 2009 to December 2015, i.e., after the GFC, was denoted as Period B. The data were acquired from Statistics Korea (KOSTAT).

2. Background

2.1. Fluctuations in Housing Market with Respect to Interest Rate in the Republic of Korea

In this section, changes in the housing market of the Republic of Korea were analyzed with respect to the structural characteristics of interest rates. Figure 1 illustrates the trends of the housing market (housing transaction and rent prices) before and after the GFC, which was considered the reference point. The housing transaction price surged until the GFC, remained stagnant for a long period after the crisis, and decreased from 2011. In addition, the market began to recover from the recession after 2014. In contrast, housing rent prices fluctuated periodically before the GFC; they exhibited an overall increasing trend around 2008 compared with that around 2002, albeit in a significantly narrower range than that of the housing transaction price. However, both prices exhibited opposite trends after the GFC; the housing transaction price mostly stagnated or decreased after the GFC, whereas the housing rent price steadily increased. The housing rent price increment after the GFC was larger than that before the GFC.

Figure 2 illustrates the variations in the base and spread interest rates, which constitute the mortgage loan interest rate. The results of the analysis of fluctuations in the base interest are as follows. The Government of the Republic of Korea implemented a low interest rate policy until 2005 to overcome the Asian financial crisis of 1998. After 2005, however, it increased the base interest to stabilize the rapidly increasing housing prices. Subsequently, it reduced the base interest by a significant margin to prevent an economic recession after the 2008 GFC and maintained the base interest at a low level compared to that from before. The spread interest rate exhibited an opposite trend in certain periods. The government initiated a high interest rate policy to stabilize the market between 2005 and 2008 before the GFC, while the spread decreased. Regarding the interest rate fluctuations after the GFC, the Government of Korea significantly reduced the base interest to prevent market recession, while the spread rapidly increased. These phenomena occurred because the base and spread interest rates were determined by the government and market participants, respectively. The government increased the base interest to stabilize the market when it overheated. As the market participants faced lower risks, the spread decreased. When the market was facing a depression, the government increased the base interest to revitalize the market. As the market participants faced increased risks, the spread also increased. This inverse relationship between the base and spread interest rates may hinder the purpose of the interest rate policy to stabilize the housing market.

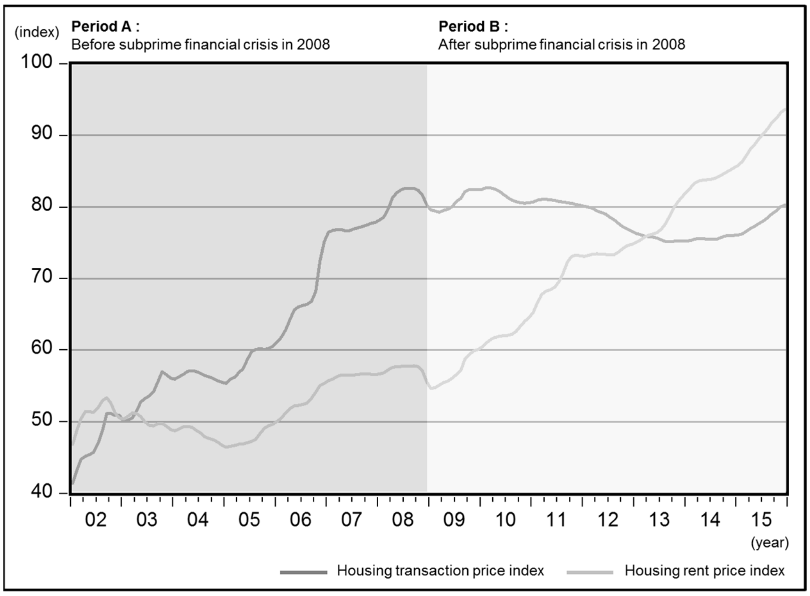


Figure 1. Changes in housing transaction and rent prices in the Republic of Korea before and after the GFC.

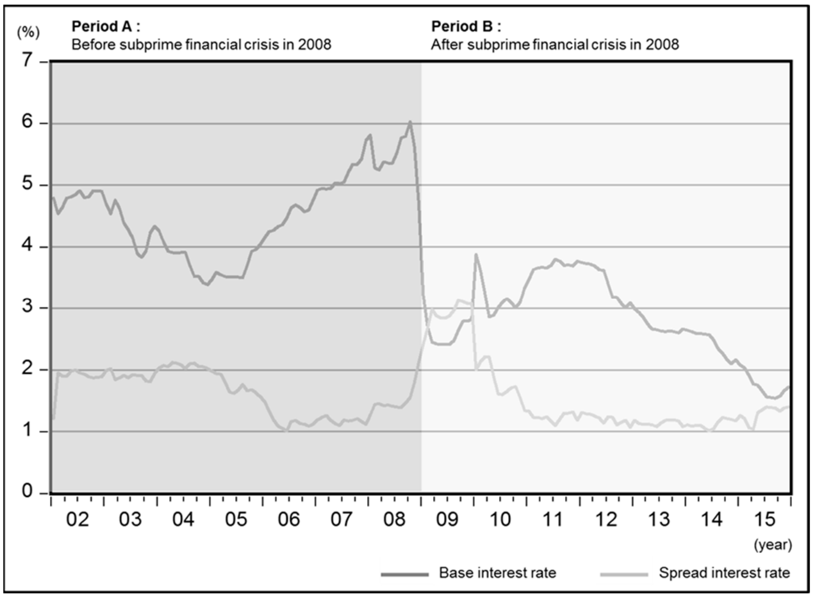


Figure 2. Variations in base and spread interest rates in the Republic of Korea before and after the GFC.

2.2. Literature Review

An unprecedented macroeconomic change such as the GFC can strongly perturb the housing market. Given that various macroeconomic factors share a dynamic relationship with the market through complex pathways, numerous studies have analyzed the structural changes of the market from the macroeconomics perspective to recommend strategies that can enhance the sustainability of the housing market. Sari et al. [14] examined the relations among the housing market activity, prices, interest rates, output, money stock, and employment in Turkey from 1961 to 2000. The results indicated that monetary aggregate had a more substantial effect on housing investment than employment. Hepsen and Vatansever [15] investigated the possibility of a long-term relationship between macroeconomic indicators and the property price index in Dubai and discovered a long-term positive equilibrium relationship not only between housing and gold prices but also between housing prices and the volume of total direct foreign trade. However, they also discovered a negative long-term relationship between housing prices and the number of completed residential units. Gustafsson et al. [16] conducted a quantitative assessment of the macroeconomic effects of a considerable decline in the housing prices using a Bayesian vector autoregression (VAR) model. They reported that a 20% drop in the housing prices led to a recession-like impact on household consumption and unemployment. Panagiotidis and Printzis [17] assessed the interdependence between the housing price index and its macroeconomic determinants within a VECM framework. They demonstrated that the variables, mortgage loans and retail trade, had the best explanatory powers for the variation of the housing price index. Chu [18] developed a dynamic stochastic general equilibrium model to analyze the transmission mechanisms of the real-estate transfer tax and other macroeconomic policies on Taiwan's housing market. This study indicated that imposing a residential property tax or raising interest rates effectively curbed speculative housing transactions and had prolonged effects on regulating housing prices over time.

These studies suggested interest rate as a crucial macroeconomic factor that significantly influenced shifts in the demand between housing transaction and rent markets. Therefore, several studies analyzed the dynamic relationship between the interest rate and changes in the housing market. Harris [5] examined the role of appreciation expectations in overcoming the negative impact of nominal mortgage interest rates on housing prices. They showed that the real rate of interest, from the perspective of the homebuyer, is the mechanism that affects changes in the housing price levels. Cho and Ma [6] identified a long-term relationship between housing values and interest rates in the Korean housing market using a co-integration test and spectral analysis. They found that the interest rate adjustment policy in the Korean housing market could work effectively and contribute to forecasting the growth rate of future housing values. Hanson and Martin [4] estimated the amount of mortgage interest deducted on federal tax returns to capture the full range of the housing market distortions from the mortgage interest deduction. Sun and Tsang [19] examined whether the interest rate rule should respond to housing price inflation to minimize the losses incurred on policymakers. Their findings indicated that the optimal rule responds to the housing price inflation even when the stabilization of the housing price is not among the objectives of the policymakers and that the strength of the response depends critically on a few structural parameters. Tse et al. [13] investigated the impact of the 2007–2008 GFC on the relationship between real mortgage interest rates and real housing prices. They demonstrated the important role of interest-rate-based monetary policies in the housing market.

As the interest rate has practical significance for housing prices, the government uses it as a tool for intervening in the housing market. In this regard, various studies have investigated interest rate policies to ensure the sustainability of the housing market. Vargas-Silva [20] examined the impact of monetary policy shocks on the US housing market. Their study suggested that the impact of monetary policy on the housing market was uncertain under the sign restrictions approach. Wadud et al. [9] modeled the role of a monetary policy in the Australian housing market using a structural VAR model and showed that the monetary policy rule in Australia considered the changes in housing prices along with the usual targets of inflation and output gap. Luciani [21] studied the role of the US Federal Reserve's policy in the recent boom and bust of the country's housing market and in the ensuing recession. They showed that a more restrictive policy may have smoothed the cycle but could not prevent recession. Zhu et al. [22] investigated the influence of monetary policy stance and mortgage market structure on the non-fundamental house price movements in 11 Euro area countries. They revealed that a one-time monetary-easing shock could significantly trigger housing price booms in Euro area countries with liberal mortgage markets. Ume [7] investigated the relationship between monetary policy and housing market activity using a relatively new method for identifying monetary shocks.

The results of these studies indicate that interest rate policies were used as an essential tool for controlling the housing market environment and that their effects depended on various conditions. The studies examined the effectiveness of interest rate policies related to the housing market circumstances and their relationship with various factors. However, few studies have analyzed changes in the housing market by reflecting on the structural characteristics of interest rates. Therefore, this study analyzed the effects of the base interest and spread, which constitute the mortgage loan interest rate, on the housing market in the Republic of Korea before and after the GFC through the VECM.

2.3. Vector Autoregression (VAR) Model

Macroeconomic variables mutually influence one another. In this context, the VAR model can be used without losing useful information because it does not place constraints on specific economic theories that affect the structural relationships among its variables. Therefore, the VAR model is considered a dynamic model that leverages the mutual influences of variables to analyze time-series data.

The model consists of n linear regression equation(s), and each equation establishes as dependent variables the currently observed values of those variables that share a causal relationship, and its previously observed value and previously observed values of other variables, as the explanatory variables. By introducing a time lag p for $N \cdot 1$ (vector) of the macroeconomic variables Y_t, we expressed the model by the following regression equation:

$$Y = \alpha_0 + \sum_{i=1}^{n} \alpha_t Y_{t-1} + e_t, \quad (1)$$

Here, Y_t is the $N \cdot 1$ (vector) for macroeconomic variables, α_t is a coefficient matrix, e_t is a probabilistic error term, and L is an operator for the time lag. Accordingly, $L^1 Y_t = Y_{t-1}$, $L^2 Y_t = Y_{t-1}$, $\cdots$, $A(L) = A_1 L^1 + A_2 L^2 + A_3 L^3 + \cdots$. If the VAR model contains unstable time-series data, the difference between the level variables is obtained and applied to the analysis. In this process, the model could lose the unique data of the level variables. If a long-term linear relationship or co-integration exists between these unstable level variables, the VECM can be used in the analysis. This model is a limited version of the VAR model used when co-integration exists. It reflects the co-integration relation among time-series data as well as other short-term dynamic relations. The equation of the model is:

$$\Delta X_t = \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \alpha \beta' X_{t-p} + u_i \quad (2)$$

where B is an $(n \times r)$ matrix representing a co-integration relation. The $\beta' X_{t-p}$ term is an r linear combination(s), indicating a disequilibrium error at the time of $t - p$. This disequilibrium error affects $\{X_t\}$ at the subsequent time t through the coefficient α. For this reason, the $(n \times r)$ coefficient matrix α is called an error correction coefficient. In this paper, a co-integration test was actually conducted, and, as the result showed that co-integration existed, the empirical analysis was conducted using the VECM.

3. Theoretical Framework

This study analyzed the effects of the base interest and spread on the housing market using the Fisher–DiPasquale–Wheaton (FDW) model. The FDW model is a four-quadrant model that defines the equilibrium between demand and supply in the property market and identifies the relationship between space and asset markets. In other words, it explains the market equilibrium based on the demand–supply model. According to this model, property development occurs when an imbalance between demand and supply in the space market leads to the generation of profits in the asset market. Accordingly, changes in macroeconomics, such as interest rates, economic growth, and liquidity, increase the demand for space in the property market. Property development is implemented when the value of a property as an asset leads to the generation of profits. The long-term equilibrium price in the space market is determined through this process [23,24].

The asset and space markets are related through the level of rent established in the latter and the volume of buildings to be constructed in the former. First, the level of rent determines the demand for real assets. Investors generally purchase property by predicting their current or future earnings. That is, a change in rent in the space market directly affects the demand for assets in the capital market. Second, the volume of buildings to be constructed serves as a crucial link between the two markets. An increase in the volume leads to a decrease in the asset prices in the asset market as well as a decrease in rent in the space market. The four-quadrant model shown in Figure 3 presents the correlation between the space and asset markets.

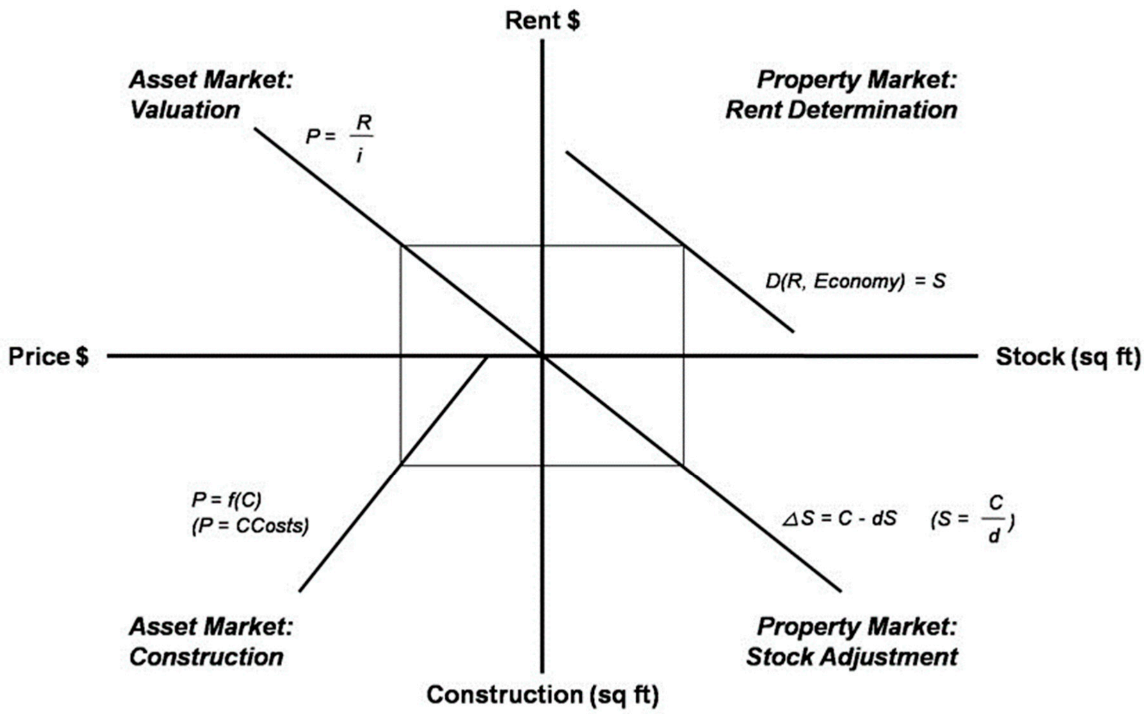


Figure 3. Fisher-DiPasquale-Wheaton (FDW) model.

In particular, the second quadrant in the FDW model is closely related to the interest rate (Figure 3). The coordinate axis of the second quadrant indicates the rent and housing prices. Conceptually, a linear graph beginning from the initial point in the second quadrant illustrates the cap rate of property assets. The cap rate shows the ratio of rent to price, indicating the current rate of return that investors require to possess property assets. Ideally, from the perspective of the housing market, the cap rate is consistent with the mortgage loan interest when the housing market is in equilibrium.

However, as shown in Figure 4, the housing market shares dynamic relationships with numerous variables, including the macroeconomic factors and elements related to the demand and supply. Thus, the market enters a state of disequilibrium. In particular, the relationship between housing transactions and rent prices is defined as an inverse relationship in the second quadrant, according to the movement of housing demand for housing. As shown in Figure 4, *i* decreases when the housing market booms. Meanwhile, the government implements interest rate policies for increasing the mortgage loan interest rates to reduce the financing capacities of people related to the housing demand for housing. In contrast, *i* increases when the housing market busts. Meanwhile, the government implements low interest rate policies to revitalize the housing market, which encourages the smooth entry of the housing demand into the housing transaction market.

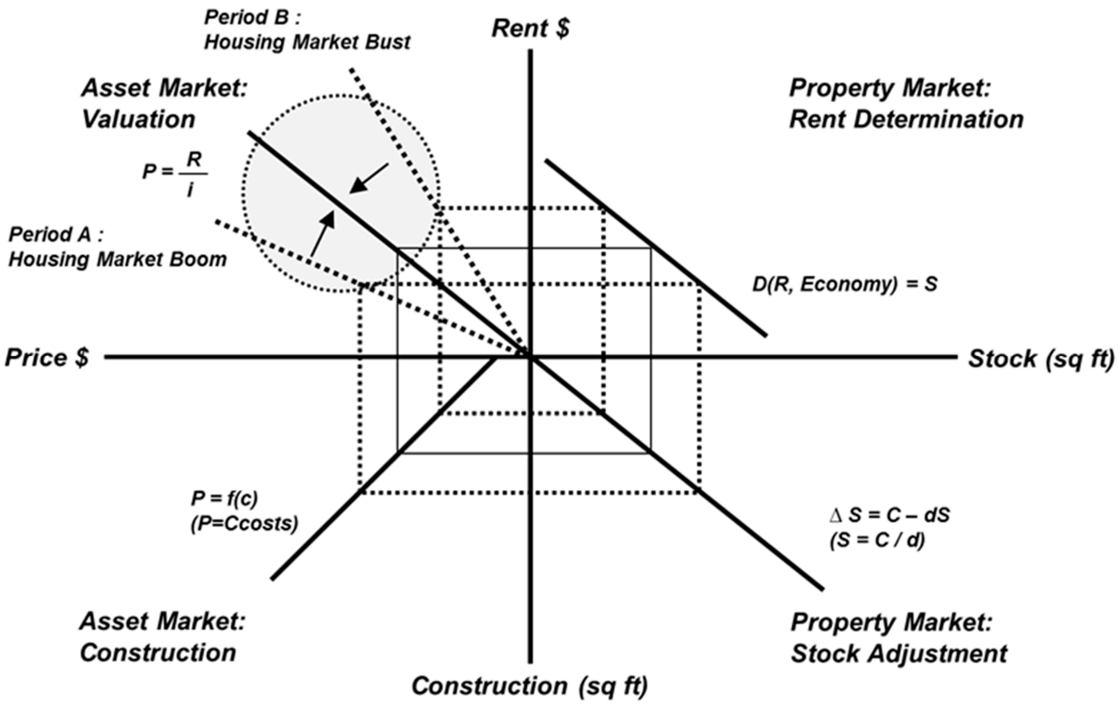


Figure 4. Dynamic FDW model (the second quadrant).

As mentioned above, the mortgage loan interest rate consists of the government-mandated base interest and the spread formed in the market. Therefore, a change in the housing market should be analyzed based on the structural characteristics of the mortgage loan interest rate to examine the effects of interest rate policies.

4. Empirical Analysis

4.1. Empirical Procedure

The variables for this study were established based on the FDW model (Table 1). As mentioned earlier, the housing market is classified into the housing transaction (asset market) and housing rental (property market) markets. This study considered the housing transaction and housing rent price indices as variables for the respective markets. It also defined the index of an industrial product, which refers to the level of industrial production activity in the Republic of Korea, as a macroeconomic variable for the first quadrant in the FDW model. As this coincident indicator behaves akin to the entire economic state, it was utilized as a proxy variable indicating the macroeconomics of the Republic of Korea. In the FDW model, a dynamic model is completed according to the movement of the housing demand between the space and asset markets. Most buyers avail loans to purchase houses as they are expensive. The interest rate is an important element to consider in loan procurement. In this regard, a change in the interest rate will have a considerable effect on the movement of the housing demand. By considering this critical relationship between the housing market and the interest rate, the government enforces interest rate policies to safeguard the market's sustainability.

Table 1. Variables and descriptions.

Series	Descriptions	Period		Frequency
		A	B	
HTI	Housing Transaction Price Index	2002:01–2008:12	2009:01–2015:12	Monthly
HRI	Housing Rent Price Index	2002:01–2008:12	2009:01–2015:12	Monthly
IIP	Index of Industrial Product	2002:01–2008:12	2009:01–2015:12	Monthly
BIR	Base Interest Rate	2002:01–2008:12	2009:01–2015:12	Monthly
SIR	Spread Interest Rate	2002:01–2008:12	2009:01–2015:12	Monthly
CCI	Construction Cost Index	2002:01–2008:12	2009:01–2015:12	Monthly
HS	Amount of Housing Supply	2002:01–2008:12	2009:01–2015:12	Monthly

This study found that the effectiveness of interest policies is ultimately affected by the characteristics of the base interest established by the government and the spread interest determined by the market. Thus, the interest rate, the element in the second quadrant of the FDW model, was categorized into the base and spread interests for analysis. Moreover, the construction cost index was utilized as a proxy variable for the construction cost, the element in the third quadrant of the FDW model. Finally, the volume of housing supply was selected as an analytic variable. This variable is closely related to the fourth quadrant of the FDW model. That is, a change in the amount of housing stock is closely associated with the space market. Data on the volume of housing supplies were acquired from KOSTAT and used to verify the close relationship between the change in the amount of housing stock and the space market. As mentioned earlier, January 2002 to December 2008, Period A, and January 2009 to December 2015, Period B, were chosen as the analytic periods to investigate the structural changes in the housing market before and after the GFC, respectively. Period A, the phase of economic invigoration, and Period B, the phase of economic recession after the financial crisis, were set to seven years each. The dynamics of the housing market were analyzed by reflecting on these periods and the structural characteristics of interest rates.

Conducting a time-series analysis with non-stationary serial data leads to spurious regression where the variables falsely appear to be correlated [25]. Therefore, it is necessary to ensure the stationarity of serial data by identifying the existence of a unit root. If a unit root does exist, the serial data are non-stationary. Therefore, a representative unit-root test called the augmented Dickey–Fuller test was conducted. Table 2 presents the results of this test. As for the level variables, most DF-t statistical values had significance levels greater than 1%, 5%, and 10% in both periods. Thus, the null hypothesis that a unit root exists was not rejected. Accordingly, the unit root test was conducted under the condition that the first difference of level variables in periods A and B was applied. Based on the test results, the null hypothesis that the unit root exists was rejected at the significance levels of 1%, 5%, and 10%.

In this context, spurious regression occurs when a traditional regression analysis method is applied to variables determined as non-stationary time-series data through a unit root test. For this reason, a correlation analysis of non-stationary time-series data based on a simple regression would yield statistically insignificant results. However, a traditional regression analysis could produce significant results if the non-stationary time-series data shared a co-integration relationship. The VECM should be used for the regression analysis if such a relation exists [26].

To confirm the relationship, an optimal time lag test was performed before the co-integration test. As an error occurs when the length of the time lag is set randomly, the optimum time lag should be tested based on the information theory to ensure the reliability of the study. In general, methods such as the Akaike information criterion (AIC) and Schwarz information criteria (SIC) are utilized to determine the time lag p of the VAR(p) model. The minimum point under each criterion is the optimal time lag. Though the explanatory power of the model is enhanced when a new variable is introduced, the degree of freedom decreases at the same time because the size of the model grows. Therefore, a shorter time lag was selected to ensure a simple model [27]. Thus, the optimal time lag test was performed, and time lag 1 was determined as the optimal time lag for periods A and B according to the SIC. Table 3 presents the results of the optimal time-lag test.

Table 2. Tests for unit roots (augmented Dickey–Fuller tests).

Period	Variables	Level		First Differencing	
		t-Statistic	*p*-Value	*t*-Statistic	*p*-Value
Period A	HTI	−2.597662	0.2826	−5.507566	0.0001
	HRI	−2.722440	0.2308	−2.067782	0.0378
	IIP	−1.000614	0.9378	−14.24309	0.0000
	BIR	−1.608673	0.7811	−5.209609	0.0003
	SIR	0.418461	0.9989	−10.38714	0.0000
	CCI	−2.529393	0.3136	−6.678412	0.0000
	HS	−5.898865	0.0000	−10.31797	0.0000
Period B	HTI	−1.613514	0.7793	−2.684829	0.0078
	HRI	−2.408066	0.3727	−4.643351	0.0017
	IIP	−5.249709	0.0002	−12.43069	0.0000
	BIR	−1.085563	0.9249	−5.901044	0.0000
	SIR	−1.116582	0.9196	−6.805125	0.0000
	CCI	0.758087	0.9997	−6.574537	0.0000
	HS	−5.693430	0.0000	−7.944240	0.0000

Note: The number of lags is selected using the Schwarz information criterion with p_{max} = 11.

Table 3. Lag specification results.

Period A			Period B		
Lag	AIC	SIC	Lag	AIC	SIC
0	−29.68376	−29.46908	0	−34.89967	−34.68500
1	−31.71228	−29.99490	1	−36.98232	−35.26493
2	−31.81273	−28.59264	2	−37.13441	−33.91432
3	−31.74442	−27.02162	3	−37.05441	−32.33161
4	−31.83241	−25.60690	4	−36.92468	−30.69917
5	−32.34564	−24.61742	5	−37.13481	−29.40659
6	−33.01285	−23.78192	6	−37.48848	−28.25754
7	−33.44568	−22.71204	7	−38.45987	−27.72623

Accordingly, this study used a representative co-integration method called the Johansen test. The results of the test rejected the null hypothesis that "the number of co-integrated vectors is smaller than or consistent with r" (Table 4). Thus, the existence of a co-integration relation between the level variables at the 5% significance level is verified. Therefore, the VECM can be used for the regression analysis.

The results of the VECM vary by the order of the endogenous variables. Hence, the arrangement order must be determined based on the causal relationships of the variables before establishing the VECM. To this end, the Granger causality test, which can clearly distinguish a causal variable from an outcome variable, was performed using a time lag distribution model without the economic theories [28].

Table 5 summarizes the results of the test in Period A, where causality follows the order of SIR ▹ IIP ▹ HRI ▹ HTI ▹ BIR ▹ CCI ▹ HS. Table 6 illustrates the results of the test in Period B, where causality obeys the order of SIR ▹ BIR ▹ HTI ▹ CCI ▹ HRI ▹ IIP ▹ HS. Based on the results, an analysis model was established with variables arranged according to Periods A and B.

4.2. Results

In impulse response analysis, one standard deviation shock is applied to variables in an analysis model to observe changes in those and other variables and examine their correlations and ripple effects [29]. In this study, the dynamic relationship between the housing market and the base interest and spread was analyzed through the impulse response analysis (Figure 5 and Table 7).

Table 4. Co-integration test results.

Period	Null Hypothesis	Test Statistic	0.05 Critical Value	p-Value
Period A	r = 0	260.5316	125.6154	0.0000
	r ≤ 1	180.8489	95.75366	0.0000
	r ≤ 2	122.9554	69.81889	0.0000
	r ≤ 3	70.82711	47.85613	0.0001
	r ≤ 4	30.64462	29.79707	0.0399
	r ≤ 5	13.70103	15.49471	0.0915
	r ≤ 6	3.416958	3.841466	0.0645
Period B	r = 0	250.0158	125.6154	0.0000
	r ≤ 1	159.3168	95.75366	0.0000
	r ≤ 2	91.22472	69.81889	0.0004
	r ≤ 3	42.86900	47.85613	0.1358
	r ≤ 4	16.54639	29.79707	0.6733
	r ≤ 5	8.283749	15.49471	0.4356
	r ≤ 6	2.231740	3.841466	0.1352

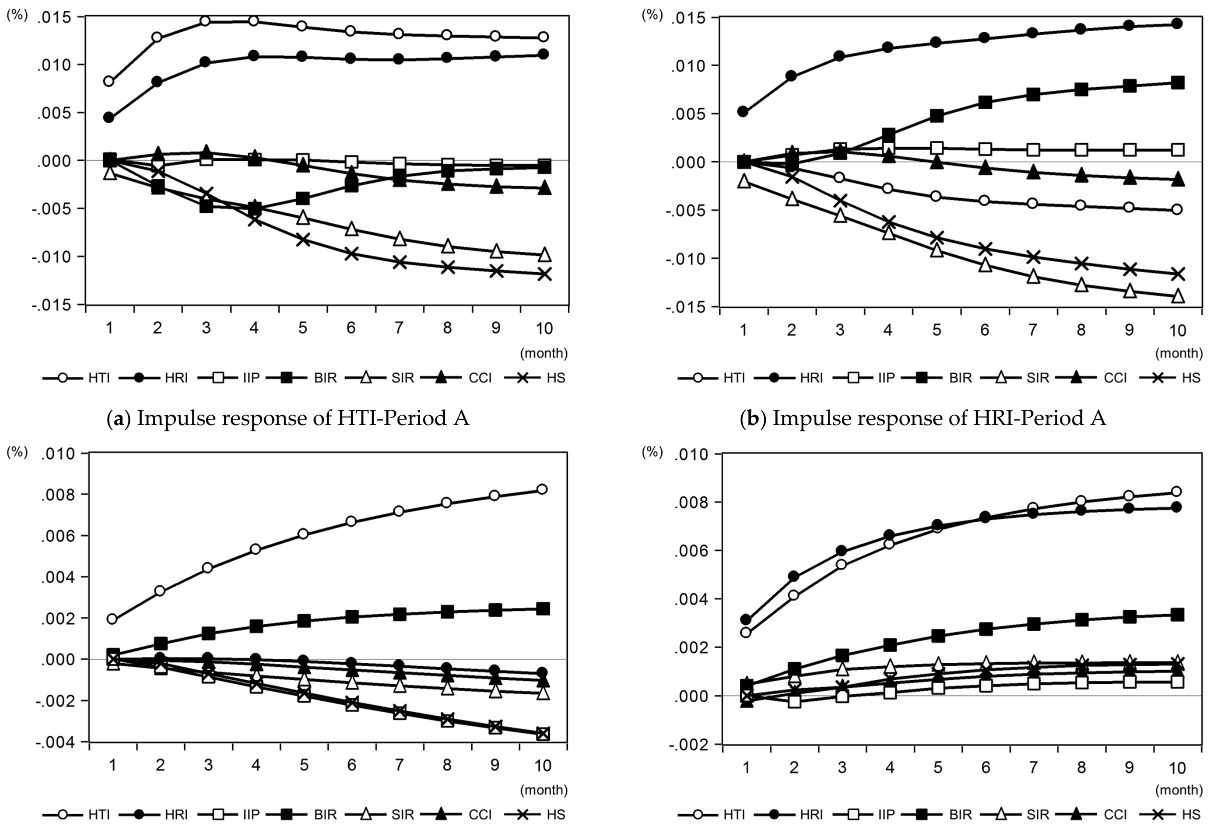
Note: Significant at 5% level, r is co-integration rank.

Table 5. Results of Granger causality test—Period A.

Causality			Lag	F-Statistic	p-Value	Causality			Lag	F-Statistic	p-Value
HRI	→	HTI	1	3.73193	0.0569	SIR	→	HRI	2	6.41303	0.0027
IIP	→	HTI	1	9.36719	0.0030	HRI	→	SIR	2	8.06338	0.0007
HTI	→	IIP	1	6.62869	0.0119	HRI	→	CCI	2	4.70740	0.0118
SIR	→	HTI	1	24.4961	4×10^{-6}	SIR	→	IIP	2	3.02987	0.0541
CCI	→	HTI	1	4.97067	0.0286	CCI	→	IIP	2	3.09903	0.0508
HTI	→	CCI	1	3.46920	0.0662	IIP	→	CCI	2	3.92097	0.0239
HTI	→	HS	1	4.43813	0.0383	IIP	→	HS	2	2.61289	0.0798
HRI	→	BIR	1	10.2531	0.0020	SIR	→	BIR	2	3.17920	0.0471
SIR	→	HRI	1	22.6100	9×10^{-6}	BIR	→	SIR	2	6.64763	0.0022
CCI	→	HRI	1	3.11893	0.0812	BIR	→	CCI	2	4.12852	0.0198
HRI	→	CCI	1	9.64100	0.0026	CCI	→	HS	2	4.46324	0.0147
IIP	→	BIR	1	4.27651	0.0419	HRI	→	HTI	3	3.07900	0.0326
IIP	→	CCI	1	6.92301	0.0102	IIP	→	HTI	3	4.72431	0.0045
SIR	→	BIR	1	10.5770	0.0017	HTI	→	BIR	3	2.20424	0.0947
BIR	→	SIR	1	6.32510	0.0139	SIR	→	HTI	3	3.38685	0.0225
BIR	→	CCI	1	11.6217	0.0010	HTI	→	CCI	3	3.19596	0.0283
HS	→	SIR	1	3.18229	0.0782	IIP	→	HRI	3	2.65321	0.0548
HS	→	CCI	1	5.95856	0.0169	HRI	→	IIP	3	2.24043	0.0906
CCI	→	HS	1	7.65357	0.0070	HRI	→	BIR	3	5.40762	0.0020
HRI	→	HTI	2	3.21891	0.0454	SIR	→	HRI	3	6.09568	0.0009
HTI	→	HRI	2	3.04610	0.0533	HRI	→	SIR	3	2.47565	0.0680
IIP	→	HTI	2	7.83089	0.0008	HRI	→	CCI	3	2.34927	0.0794
HTI	→	BIR	2	5.05884	0.0086	IIP	→	BIR	3	3.10813	0.0315
SIR	→	HTI	2	2.92595	0.0596	SIR	→	IIP	3	2.85927	0.0426
HTI	→	SIR	2	3.04233	0.0535	CCI	→	IIP	3	4.40437	0.0066
HTI	→	HS	2	2.44480	0.0935	IIP	→	CCI	3	3.62428	0.0168
IIP	→	HRI	2	3.28848	0.0426	SIR	→	BIR	3	4.19141	0.0085
HRI	→	IIP	2	2.44175	0.0937	BIR	→	SIR	3	4.10285	0.0095
HRI	→	BIR	2	9.87226	0.0002	CCI	→	HS	3	3.83312	0.0131

Table 6. Results of Granger causality test—Period B.

Causality			lag	*F*-Statistic	*p*-Value	Causality			Lag	*F*-Statistic	*p*-Value
BIR	→	HTI	1	72.9319	7×10^{-13}	SIR	→	BIR	2	3.11274	0.0501
HTI	→	BIR	1	5.91948	0.0172	CCI	→	BIR	2	3.84207	0.0257
SIR	→	HTI	1	14.2170	0.0003	BIR	→	CCI	2	2.95832	0.0578
HTI	→	CCI	1	3.23787	0.0757	SIR	→	CCI	2	6.57600	0.0023
HRI	→	IIP	1	29.8103	5×10^{-7}	HS	→	SIR	2	3.55786	0.0333
BIR	→	HRI	1	2.87868	0.0936	SIR	→	HS	2	8.11680	0.0006
HRI	→	HS	1	13.6365	0.0004	HS	→	CCI	2	7.36448	0.0012
SIR	→	IIP	1	5.32954	0.0235	CCI	→	HS	2	5.85161	0.0043
IIP	→	SIR	1	4.07574	0.0469	HTI	→	HRI	3	2.69257	0.0522
CCI	→	IIP	1	21.8033	1×10^{-5}	IIP	→	HTI	3	3.16869	0.0293
IIP	→	CCI	1	17.0963	9×10^{-5}	BIR	→	HTI	3	2.60009	0.0585
IIP	→	HS	1	15.4815	0.0002	HTI	→	BIR	3	2.20726	0.0943
BIR	→	CCI	1	9.19708	0.0033	HRI	→	IIP	3	5.27799	0.0024
SIR	→	CCI	1	16.0835	0.0001	HRI	→	BIR	3	2.81971	0.0447
HS	→	SIR	1	8.65835	0.0043	BIR	→	IIP	3	3.28211	0.0255
SIR	→	HS	1	18.4463	5×10^{-5}	CCI	→	IIP	3	4.23170	0.0081
HS	→	CCI	1	8.45508	0.0047	IIP	→	CCI	3	3.09337	0.0321
CCI	→	HS	1	14.7874	0.0002	HS	→	IIP	3	3.19981	0.0282
IIP	→	HTI	2	2.95820	0.0578	IIP	→	HS	3	3.45983	0.0206
BIR	→	HTI	2	4.68830	0.0120	SIR	→	BIR	3	2.89267	0.0409
HTI	→	BIR	2	2.86068	0.0633	CCI	→	BIR	3	3.35732	0.0233
SIR	→	HTI	2	2.40103	0.0974	BIR	→	CCI	3	2.77966	0.0470
HRI	→	IIP	2	6.89184	0.0018	SIR	→	CCI	3	5.37969	0.0021
HRI	→	HS	2	4.93730	0.0096	SIR	→	HS	3	3.08570	0.0324
CCI	→	IIP	2	7.14050	0.0014	HS	→	CCI	3	4.37157	0.0069
IIP	→	CCI	2	6.98658	0.0016	CCI	→	HS	3	2.57615	0.0602
IIP	→	HS	2	6.59144	0.0023						



(**a**) Impulse response of HTI-Period A

(**b**) Impulse response of HRI-Period A

(**c**) Impulse response of HTI-Period B

(**d**) Impulse response of HRI-Period B

Figure 5. Impulse response graph.

Table 7. Fiscal impulse response results.

Category	Dependent Variable	Period (Month)	Independent Variables						
			HTI	HRI	IIP	BIR	SIR	CCI	HS
Period A (Boom)	HTI	1	0.00815	0.00439	0.00009	0.00000	−0.00133	0.00000	0.00000
		2	0.01273	0.00809	−0.00056	−0.00267	−0.00286	0.00064	−0.00113
		3	0.01441	0.01015	0.00010	−0.00481	−0.00402	0.00083	−0.00344
		4	0.01445	0.01084	0.00007	−0.00504	−0.00490	0.00029	−0.00618
		5	0.01388	0.01074	0.00002	−0.00398	−0.00600	−0.00053	−0.00827
		6	0.01338	0.01054	−0.00018	−0.00264	−0.00718	−0.00138	−0.00974
		7	0.01310	0.01048	−0.00036	−0.00164	−0.00821	−0.00205	−0.01059
		8	0.01296	0.01060	−0.00047	−0.00111	−0.00899	−0.00248	−0.01113
		9	0.01287	0.01080	−0.00052	−0.00087	−0.00952	−0.00274	−0.01153
		10	0.01276	0.01097	−0.00053	−0.00072	−0.00988	−0.00290	−0.01186
	HRI	1	0.00000	0.00510	0.00000	0.00000	−0.00204	0.00000	0.00000
		2	−0.00062	0.00882	0.00072	−0.00022	−0.00386	0.00090	−0.00154
		3	−0.00173	0.01084	0.00130	0.00087	−0.00561	0.00106	−0.00402
		4	−0.00285	0.01177	0.00143	0.00283	−0.00740	0.00061	−0.00623
		5	−0.00365	0.01230	0.00140	0.00476	−0.00919	−0.00005	−0.00787
		6	−0.00412	0.01278	0.00131	0.00616	−0.01073	−0.00065	−0.00903
		7	−0.00441	0.01326	0.00125	0.00700	−0.01192	−0.00110	−0.00986
		8	−0.00463	0.01369	0.00123	0.00750	−0.01279	−0.00141	−0.01055
		9	−0.00484	0.01403	0.00123	0.00787	−0.01344	−0.00165	−0.01114
		10	−0.00504	0.01426	0.00123	0.00821	−0.01394	−0.00184	−0.01164
Period B (Bust)	HTI	1	0.00190	0.00000	0.00000	0.00021	−0.00021	0.00000	0.00000
		2	0.00326	0.00003	−0.00040	0.00075	−0.00045	−0.00006	−0.00020
		3	0.00438	0.00003	−0.00086	0.00125	−0.00063	−0.00013	−0.00070
		4	0.00529	−0.00003	−0.00135	0.00159	−0.00081	−0.00025	−0.00118
		5	0.00603	−0.00012	−0.00179	0.00184	−0.00099	−0.00038	−0.00165
		6	0.00663	−0.00023	−0.00223	0.00204	−0.00115	−0.00052	−0.00209
		7	0.00713	−0.00035	−0.00263	0.00218	−0.00129	−0.00066	−0.00252
		8	0.00754	−0.00047	−0.00300	0.00229	−0.00143	−0.00079	−0.00291
		9	0.00789	−0.00059	−0.00334	0.00238	−0.00155	−0.00091	−0.00327
		10	0.00818	−0.00071	−0.00364	0.00244	−0.00166	−0.00103	−0.00360
	HRI	1	0.00256	0.00309	0.00000	0.00041	0.00048	−0.00021	0.00000
		2	0.00410	0.00489	−0.00025	0.00110	0.00079	0.00010	0.00024
		3	0.00537	0.00595	−0.00003	0.00166	0.00109	0.00034	0.00035
		4	0.00622	0.00659	0.00012	0.00208	0.00119	0.00052	0.00069
		5	0.00688	0.00701	0.00030	0.00246	0.00128	0.00068	0.00089
		6	0.00735	0.00729	0.00040	0.00274	0.00132	0.00080	0.00106
		7	0.00773	0.00748	0.00049	0.00296	0.00135	0.00088	0.00117
		8	0.00800	0.00761	0.00053	0.00312	0.00136	0.00094	0.00125
		9	0.00822	0.00770	0.00056	0.00325	0.00136	0.00098	0.00128
		10	0.00839	0.00775	0.00057	0.00334	0.00136	0.00101	0.00131

The results of the analysis in Period A are as follows. As observed in Figure 5a, the housing transaction price changes in the negative direction due to the impulses of the base interest and spread. This result is theoretically consistent with the mechanism of interest rate policies wherein the housing purchase price is increased by increasing the interest rate, and the housing demand is reduced. Moreover, the range of fluctuation in the housing transaction price decreased gradually when the impulse of the base interest was applied. In contrast, the range of fluctuation in the housing transaction price increased gradually when the impulse of the spread was applied. Based on this result, the market spread had more significant effects on the housing transaction price than the base interest rate modified by the government. In Period A, the risk decreased as the housing market boomed. Accordingly, the spread might also decrease during this period. Under these conditions, despite government policies to increase the interest rate for the sustainability of the housing market, the spread determined by the market decreased. As a result, the effects of the interest rate policies were weakened. Furthermore, as shown in Figure 5b, the housing rent price moves in the positive direction through the impulse of the base interest and in the negative direction through the impulse of the spread. As mentioned earlier, housing purchase costs increase when interest rates increase. The housing demand can shift to the housing rental market under these conditions, increasing the housing price.

Therefore, the housing rent price may move in the positive direction through the impulse of the base interest. In particular, the housing rent price exhibited an interesting spread-impulse behavior. Like the base interest, the spread also affects the mortgage loan interest. Therefore, the housing rent price should move in the positive direction through the impulse of the spread. However, according to the analytic result, it moved in the negative direction. This phenomenon was found to be related to the first quadrant of the FDW model. In other words, the housing transaction and rent prices increased simultaneously when the demand for space was increased due to the overall economic boom. Although the housing demand moves from rental to transaction, owing to the reduction in the spread by the market boom cycle, new demand for space can enter the rental market. Therefore, the housing rent price moves in the negative direction through the impulse of the spread.

The results of analysis of the dynamic relationship between the housing market and the base interest and spread in Period B are as follows. As shown in Figure 5c, the housing transaction price moves in the positive direction through the impulse of the base interest and in the negative direction through the impulse of spread. In particular, the housing transaction price shows interesting behavior with respect to the impulse of the base interest. As shown in Figure 5c, the transaction market did not recover despite government policies for reducing the interest rate to fuel the boom of the housing market. This result implies that the interest rate policies were not effective in the recovery of the housing market after the GFC. In addition, Figure 5c demonstrates a considerable fluctuation in the housing transaction price through the impulse of the housing transaction price itself. This phenomenon means that investor sentiment was the most crucial element affecting recovery of the housing transaction market amid economic distress. This result verified that the interest rate policies cannot bring about the recovery of the housing market but can only aid in such recovery. As shown in Figure 5d, the housing rent price moved in the positive direction when the impulses of the base interest and spread were applied, which is theoretically consistent with that of the housing rent price caused by the natural movement of housing demand affected by a change in the interest rates.

5. Conclusions

The effects of the base interest and spread, which constitute the mortgage loan interest rate, on the housing market before and after significant macroeconomic changes were analyzed based on the VECM to elucidate the policy implications for the sustainability of the housing market.

The housing market was classified into the transaction and rental markets based on the FDW model, and the transaction and rental price indices were established as proxy variables for the respective markets. The interest was divided into the base and spread interests, which were used as the variables for the model. Three other representative indices were defined: industrial product index as the macroeconomic variable in the first quadrant, construction cost index as the construction cost variable in the third quadrant, and the amount of housing supply in the fourth quadrant. As for the temporal range of time-series data, the period from January 2002 to December 2008 before the GFC was established as Period A. The period from January 2009 to December 2015 after the GFC was established as Period B. KOSTAT databases were used for the time-series data.

The analyses were conducted in Period A, the housing boom cycle, and in Period B, the housing bust cycle. The results raise a question about the effectiveness of government interest rate policies. The main purpose of these policies is to ensure the sustainability of the housing market. However, according to the results, they were effective only in the initial stage of the housing boom cycle and had diminishing market correction effects subsequently. The policies did not have any tangible effects on the housing bust cycle. In contrast, the housing transaction price had the strongest response to the impulse of the housing transaction price itself in both cycles. These analytical results indicate that the market mechanisms had more significant effects on the sustainability of the housing market than artificial political intervention. This can be also verified from the changes observed in the housing transaction price through the impulse of the market spread. In other words, the movement of the housing transaction price through the impulse of the spread is logical. Therefore, governments must reconsider housing demand-control policies based on interest rate corrections.

As observed amid the coronavirus disease (COVID-19) pandemic, interest rate policies are not limited to the housing market. Governments formulate interest rate policies according to the economic scenario of their countries. However, the overall economic situation of a country and the movement of the housing market do not coincide. For example, as the Government of Korea is maintaining low interest rates during the COVID-19 pandemic, the country has a significantly high funding liquidity. Despite a sharp rise in housing prices caused by the side effects of these policies, it cannot drastically increase the interest rates during the pandemic. Given that various factors should be reflected in the implementation of its interest rate policies, the government must ratify not only interest rate policies but also housing policies from a diverse range of aspects. In fact, there are various policies that affect the housing demand, such as loan limits and taxes. Since these policies affect the housing demand in various ways, these policies should be comprehensively reviewed along with interest rate policies.

Furthermore, the implementation of housing supply policies can be more efficient for the sustainability of the housing market. As shown in the results, housing supply stabilized the housing transaction price in Periods A and B. Thus, housing supply policies will be more effective than housing demand policies.

In order to realize the direction of housing demand and supply policy proposed in this study, the following future research is needed. First, in terms of housing demand policy, it is necessary to review the money supply. Interest rates affect the housing market because interest rates can change market liquidity. Accordingly, in order to clearly identify the problems of the housing demand policy, it is necessary to consider the movement of funds in the housing market by setting the money supply as a variable. It is also necessary to find a way to effectively supply housing. Because a country can only possess a limited area of land, further research should be conducted to analyze the range, types, and optimal volume of housing supplies by efficiently utilizing the limited area of national land and considering collaboration with the private sector.

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