Comparison of Dynamics in the Korean Housing Market Based on the FDW Model for the Periods Before and After the Macroeconomic Fluctuations

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Abstract

There is a very close relationship between the housing market and macroeconomic fluctuations. Specifically, the dynamics between the various factors of the housing market are changed by macroeconomic fluctuations. The housing market can be divided into the rental market and the transaction market. Different price movements in each market appear before and after macroeconomic fluctuations. The purpose of this study is to compare the dynamics in the Korean housing market before and after macroeconomic fluctuations based on the FDW model. Data for this study came from the apartment market in Seoul, which is a representative housing market for Korea. The timeframe of serial data are set as; period A from January 2001 to December 2006, which preceded the financial crisis, and period B from January 2007 to July 2011, which followed it. The database of Statistics Korea (KOSTAT) was used in collecting the serial data. Empirical analysis was carried out using the selected variables based on the FDW model and the results were compared for each period and each market. A substantial number of different characteristics were identified. It is believed that these results will carry significant meaning from various perspectives, including the political and business points-of-view.

Keywords: Macroeconomic fluctuations; Fisher-Dipasquale-Wheaton model; housing market; Vector Error Correction Model

1. Introduction

While the subprime financial crisis spread globally, the construction and financial markets in Korea were greatly impacted. According to information from the Construction & Economy Research Institute of Korea (CERIK), the Business Survey Index (BSI) for construction business kept falling from 80 points in December 2006 to 14.6 points in November 2008. The data also indicated that, within the construction industry, the recession in the housing market, was most serious. This clearly shows that the housing market has a very close relationship with changes in macroeconomics. That is, changes in macroeconomic conditions have a substantial influence on the housing market system. In fact, the Korean housing market had been in an active state before the financial crisis. According to Statistics Korea (KOSTAT), the Housing Transaction Price Index of Korea had been trending higher before the financial crisis; however, after the financial crisis, it fell rapidly and is still at a standstill. On the other hand, the Housing Rent Price Index had been rising at a lower rate than the Housing Transaction Price Index before the financial crisis; however, since the financial crisis, the Housing Rent Price Index is trending higher than the Housing Transaction Price Index. This suggests that the dynamics between the various factors in the transaction market and rental market changed before and after the fluctuation in macroeconomics. This will have important implications in comparing the dynamic characteristics of the transaction market and rental market before and after fluctuations in macroeconomics from the perspectives of policy and business. Nevertheless, most of the existing literature analyzed the dynamics of the housing market only from a holistic perspective. Traditional housing demand-supply models explain the housing market based on demand and supply. However, it is required to divide and analyze the housing market further because the transaction market and the rental market are showing different price movements. The Fisher-Dipasquale-Wheaton (FDW) model explains the housing market by dividing it into the asset market, which is the transaction market, and the space market, which is the rental market.
Accordingly, the purpose of this study is to compare the dynamics in the Korean housing market before and after macroeconomic fluctuations based on the FDW model. The timeframe has been divided into "before the subprime financial crisis" and "after the subprime financial crisis." The housing market was divided into the asset market, and the space market. The dynamics for each period and market have been empirically analyzed by means of Vector Error Correction Model (VECM).

The data for this study came from the apartment market in Seoul, which represents the housing market in Korea. The timeframes of serial data are set as; period A from January 2001 to December 2006, which was before the financial crisis, and period B from January 2007 to July 2011, which was after the financial crisis. The database of KOSTAT was used in collecting the serial data.

2. Background
2.1 Trend of the Korean Housing Market Before and After the Macroeconomic Change

Fig.1. is the trend of the housing transaction price, housing rent price, and rent-price ratio in reference to the subprime financial crisis. As seen in Fig.1.(a), the housing transaction price had been in a continuous rising trend before the financial crisis. However, after the financial crisis, it rose and fell repeatedly and is still in a flat state. This was caused by the decrease in investment demand after serious fluctuations in the macroeconomics. On the other hand, as seen in Fig.1.(b), the housing rent price had also been in a rising trend; however, the rising increment of the housing rent price had been smaller than the rising increment of the housing transaction price before the financial crisis. However, it can be seen that the housing rent price continues the rising trend after the financial crisis, which is different from the housing transaction price. It is believed that this was caused by space demand remaining in the space market, thereby not moving to investment demand. The rent-price ratio also shows characteristic trends before and after the financial crisis. Specifically, the rent-price ratio had continuously decreased before the financial crisis but is in a continuous increasing trend following the financial crisis. Likewise, it is believed that changes in the trend of housing transaction price and housing rent-price were due to the impacts of macroeconomic fluctuations on the dynamic relationship of various factors. Along this line, it is judged that the comparison of housing market dynamics before and after the macroeconomic fluctuations will have important meaning from the perspectives of policy and business.

2.2 Literature Review

The supply-demand in housing market changes according to complex relationships between various factors. Therefore, there has been a substantial amount of literature that has analyzed the impact of various factors on housing market system movement.

Haurin et al. (1998) analyzed the determination mechanism of household demand for owner-occupied housing by various factors from the perspective of housing demand. Borsch-Supan et al. (2001) analyzed the cross-national differences in the structure of housing demand in Germany and Japan by means of a questionnaire survey.

From the perspective of housing supply, Somerville (1999) analyzed the relationship between housing starts and construction costs using the new set of micro-data on housing construction costs. Glaeser et al. (2008) presented a simple model of housing bubbles that predicts that places with a more elastic housing supply have fewer and shorter bubbles, with smaller price increases. There are multiple sources that analyzed the forming process of housing price by the housing supply-demand. Case et al. (1996) analyzed the pattern of house price appreciation in the Boston area from 1982 to 1994. The analysis result suggested that the changes in the cross-sectional pattern of house prices are related to manufacturing employment, demographics, and new construction. Hort (1998) analyzed real house price changes using the Swedish panel data. The analysis suggested that movements in income, user costs, and construction costs have important impacts on real house prices. Oikarinen

![Fig.1. Trend of Korean Housing Market Before and After the Macroeconomic Fluctuations](image-url)
(2009) analyzed the relationship between household debt and housing price in Helsinki.

All these various studies mentioned that the macroeconomic fluctuations have important impacts on the housing market. There have also been multiple studies that analyze by adding the macroeconomic variables in the model. However, it has been found that there is no study that carried out an empirical analysis; even though the movements between the housing supply and demand are different from each other before and after the rapid fluctuation of macroeconomics. Since the movement of the housing market becomes very different depending upon the macroeconomic fluctuations, it is judged that the empirical analysis will be very meaningful from the perspectives of policy, business, and society. Therefore, this study empirically analyzed the housing market dynamics of each period before and after the subprime financial crisis and the results have been compared.

2.3 Vector Auto Regression Model (VAR)

The Vector Auto Regression Model (VAR) does not apply restrictions on specific economic theory regarding the structural relationship among the variables in the model; therefore, in reality it can be used without losing useful information. It can be said that VAR is a dynamic model that gives inter-variable impacts for the analysis of multiple serial data. VAR consists of numbers of linear regression formula. Each equation has the current observation values of variables that have a cause-and-effect relationship with each other as the dependent variable. The past observation values of itself and other variables are set up as the explanation variables. In general, the VAR has that time-difference p against the \( N \times I \) (vector) macroeconomics variables. \( Y \) can be expressed as the following regression equation.

\[
Y = a_0 + \sum_{i=1}^{n} a_t Y_{t-1} + e_t
\]

Here, \( Y \) is \( N \times I \) (vector) of macroeconomic variables, \( a_t \) is the coefficient matrix, \( e_t \) is the probability error, \( L \) is the time operator, which is expressed as \( L^j Y = Y_{t-j} \), \( L^j Y = Y_{t-j} \), \( \cdots \), \( A(L) = A_0 + A_1 L + A_2 L^2 + \cdots \). However, when the serial data of VAR is non-stationary, it is possible that the unique information in the level variables can be lost.

In this case, if there is a cointegration, which is the long-term linear relation between the unstable level variables, it is possible to carry out the analysis using the Vector Error Correction Model (VECM). VECM is a limited form of VAR that is used when there is a co-integration. The dynamic model of it can be expressed as follows, which considers the cointegration relationship between time series together with other short-term dynamic relations.

\[
\Delta X_t = \sum_{i=1}^{j-1} \gamma_i \Delta X_{t-i} + a \beta' X_{t-j} + u_t
\]

Here, \( \beta \) is the \( (n \times r) \) matrix that expresses the cointegration relationship. The \( \beta' X_{t-j} \) term, which is \( r \) linear integrations, expresses the unbalanced error at the timing of \( t-j \). This unbalanced error affects the \( \{ X_t \} \) of next \( t \) timing by coefficient \( a \). The \( (n \times r) \) coefficient matrix \( a \) is called the "error-correction coefficient" due to the above reasons. In this study, a cointegration test has been actually conducted in Chapter 4. The result revealed that there is a cointegration; therefore, an empirical analysis was carried out using the VECM.

3. Theoretical Framework

This study used the Fisher-Dipasquale-Wheaton (FDW) model in the analysis of housing market dynamics before and after the macroeconomic fluctuations. The traditional housing supply-demand model explains the housing market by dividing the market into housing demand and supply. However, the housing market is divided into a space market, which is made by actual necessity of residential space, and an investment market. From this perspective, the housing supply-demand model has its limitations in explaining the housing market. The FDW model used as the theoretical framework of this study is the expanded version of the traditional housing supply-demand model. It divides the real estate market, which includes the housing market into a space market and an asset market then constructs a 4-quadrant model considering the relationship between the markets.

Fig 2. is the relationship between the space market and the asset market. In summary, the space market determines the rent price and then this rent price is again converted to the asset price of each space by the asset market. This asset price again activates new construction quantity, which returns to the space market and becomes housing stock. The space market and the asset market linked like this produce a balanced state if there is no change in housing stock. If the housing stock after the cycle has been completed is different from the initial housing stock, it means that the 4 variables of the FDW model are not in a balanced state.

![Fig 2. FDW Model](image-url)
As seen in Fig.3. below, this study enabled the authors to confirm the housing market dynamics intuitively depending upon the macroeconomic fluctuations under the FDW model.

The status of the Korean housing market is currently unstable under the FDW model. Increasing space price means that the asset market becomes active, while a decreasing asset price means that it becomes stagnant. In the second quadrant, the space and asset price are in direct proportion but in a trade-off relationship. This relationship means that supply and demand are not fluent from the property market to asset market.

However, the dynamics can be different depending upon the extent of the macroeconomic fluctuations. Therefore, this study differentiated the time period before and after the subprime financial crisis that had caused the rapid macroeconomic fluctuations. The dynamics of the space market and asset market during each period were empirically analyzed and the results were compared.

4. Empirical Analysis
4.1 Empirical Procedure
In this study, variables were selected based on the FDW model. Basically the housing market has been divided into the rental market (property market) and the transaction market (asset market). The dynamics between the rental market and the transaction market were then analyzed depending on the macroeconomic fluctuations. Accordingly, the variables were set up as housing transaction price, housing rent price, economic variable, rent-price ratio, construction cost, and amount of housing supply, which were the major variables under the FDW model.

Regarding the serial data of each variable, the housing transaction price used the Housing Transaction Price Index (HTPI), the housing rent price used the Housing Rent Price Index (HRPI), the economic variable used the Coincident Composite Index (CCI), the rent-price ratio used the Rent-Price Ratio (RPR), the construction cost used the Construction Cost Index (ConCI) and the amount of housing supply used the Amount of Housing Construction Contract (ACC). The required data was obtained from KOSTAT.

The timeframe of serial data for the analysis of housing market dynamics depending upon the macroeconomic fluctuations was set as; period A is from January 2001 to December 2006, which preceded the subprime financial crisis that caused the recent global macroeconomic fluctuations, and period B is from January 2007 to July 2011, which followed the subprime financial crisis. The housing market dynamics were examined for period A in which the market was active, also for period B, which was a recession period after the financial crisis, and the two were compared accordingly.

When performing a series analysis, the stationary nature of the series data should be secured. If the serial data was non-stationary and a series analysis has been carried out, the spurious regression phenomenon appears, in which the variables appear to have high correlations, although they actually do not have such high correlations. In order to examine the stationary of serial data, the existence of a unit root in the serial data should be checked. If there is a unit root, it means that the serial data is non-stationary (Granger et al., 1974). In this study, the ADF (Augmented Dickey-Fuller) test, which represents the unit root test, was used to test the stationary of serial data. The result of the unit root test suggested that, in the case of level variables, most of the DF-t statistical values in the period A and period B were bigger than 1%, 5% and 10% significance levels; therefore, they could not reject the null hypothesis assuming the existence of unit root. However, when the level variables of period A and period B were then differentiated and the unit root test was carried out, the null hypothesis assuming the existence of the unit root could be rejected at 1%, 5% and 10% significance level.

When the non-stationary serial data is converted to stationary variables through the differentiation process, the long-term change content included in the raw data can be lost. However, if there is a linear combination between the non-stationary serial data, it is possible to create stationary serial data. This is called

![Fig.3. The Movements of FDW Model Dependent on the Macroeconomics Fluctuation](image-url)

### Table 1. Tests for Unit Roots (Augmented Dickey-Fuller Tests)

| Period | Variables | Level | 1º differencing |
|--------|-----------|-------|-----------------|
|        |           | t-statistic | p-value | t-statistic | p-value |
| Period A | HTPI | -2.267357 | 0.4455 | -3.787380 | 0.0230 |
|          | HRPI | -2.471885 | 0.3407 | -3.362958 | 0.0649 |
|          | CCI  | -3.130411 | 0.1080 | -3.704735 | 0.0290 |
|          | RPR  | -2.270721 | 0.4438 | -3.974958 | 0.0139 |
|          | ConCI | -0.777042 | 0.9626 | -7.962152 | 0.0000 |
|          | ACC  | -6.574350 | 0.0000 | -7.717618 | 0.0000 |
| Period B | HTPI | -2.868936 | 0.1806 | -3.312560 | 0.0760 |
|          | HRPI | -1.319158 | 0.8723 | -4.132354 | 0.0103 |
|          | CCI  | -2.605206 | 0.2798 | -3.586730 | 0.0408 |
|          | RPR  | -0.245295 | 0.9903 | -3.369482 | 0.0665 |
|          | ConCI | -2.225124 | 0.4662 | -3.612251 | 0.0000 |
|          | ACC  | -5.357142 | 0.0003 | -6.612251 | 0.0000 |
a cointegration. That is, when there is a cointegration, it is possible to conduct time series analysis using non-stationary time-series data. If there is a cointegration, the analysis should be carried out by using the Vector Error Correction Model (Eagle et al., 1987).

Table 2. Results of Lag Test for Cointegration Tests

| Period | Lag | AIC | SIC | HQ |
|--------|-----|-----|-----|----|
| 0      | -33.47650 | -33.27579 | -33.39730 | 0.0001 |
| 1      | -34.78503 | *-33.38004 | *-34.23067 | 0.0001 |
| 2      | -34.90910 | -32.29984 | -33.87958 | 0.0001 |
| 3      | -35.18866 | -31.37512 | -33.68398 | 0.0001 |
| 4      | -35.77033 | -30.75252 | -33.79048 | 0.0001 |
| 5      | -36.06878 | -29.84699 | -33.61376 | 0.0001 |
| 6      | *-36.44468 | -29.01831 | -33.51540 | 0.0001 |

* - * denotes the lowest value

Table 3. Results of Cointegration Test

| Period | Null hypothesis | Test Statistic | 0.05 Critical Value | p-value |
|--------|----------------|---------------|---------------------|---------|
| r = 0* | 160.1671       | 95.75366      | 0.0000              |         |
| r ≤ 1* | 98.58408       | 69.81889      | 0.0001              |         |
| r ≤ 2* | 52.45631       | 47.85613      | 0.0174              |         |
| r ≤ 3  | 19.97249       | 29.79707      | 0.4247              |         |
| r ≤ 4  | 7.891235       | 15.49471      | 0.4771              |         |
| r ≤ 5  | 0.447734       | 3.841466      | 0.5034              |         |
| r = 0* | 163.6596       | 95.75366      | 0.0000              |         |
| r ≤ 1* | 81.58625       | 69.81889      | 0.0043              |         |
| r ≤ 2  | 42.75866       | 47.85613      | 0.1385              |         |
| r ≤ 3  | 19.62737       | 29.79707      | 0.4485              |         |
| r ≤ 4  | 6.682363       | 15.49471      | 0.6148              |         |
| r ≤ 5  | 0.088037       | 3.841466      | 0.7667              |         |

* - Significant at 5% level
- * r is co-integration rank - * denotes no cointegration

As seen in Table 3., the results of the cointegration test rejected the null hypothesis that there was no cointegration at the 5% significance level; therefore, there are cointegrations in both period A and period B. Accordingly, this study carried out the VECM analysis based on the results.

4.2 Results

First, a variance decomposition analysis was carried out to measure the relative influences of the remaining variables on a certain variable in the model. In this study, the relative contributions to each other regarding the variables changes were measured in %.

First is period A. As seen in Fig.4.-(a), the rent-price ratio had the biggest impact on the housing transaction price change. Housing rent price and housing transaction price had the second and third largest impacts. As seen in Fig.4.-(b), housing rent price had the biggest impact on the change of housing rent price. However, as time passed, the influence gradually decreased while the influence of the amount of housing supply gradually increased.

Next is period B. As seen in Fig.4.-(c), the rent-price ratio had the biggest impact on the housing transaction price change. The housing rent price had a significant impact on the housing transaction price in the early stage; however, as time passed, the impact rapidly decreased.

As seen in Fig.4.-(d), the housing rent price had the biggest impact on the change of housing rent price. However, as time passed, the influence gradually decreased while the influence of coincident composite index was gradually increased.

Table 4. is the comparison of results of variance decomposition for period A and B. Results 1 and 2 are a comparison of variance decomposition for individual markets, viz. the asset market and space market, for the same period.

Results 3 and 4 are a comparison of variance decomposition for individual periods, viz. period A and B, for the same market.

Next, the impulse response analysis was carried out to confirm the responses of other variables when a specific variable had a unit shock. The influence of one variable shock on the variable itself and other variables in the model were measured. First is period A. As seen in Fig.5.-(a), the housing transaction price changed to the negative direction by the shock of rent-price ratio and the change extent was the largest.

The housing transaction price moved to the positive direction by the shock of housing transaction price and housing rent price. Fig.5.-(b) shows that the housing rent price changed to the positive direction by the shock of housing rent price and the change extent was the largest.

The change extent of the housing rent price for the shock of amount of housing supply which was bigger than other variables.

Next is period B. As seen in Fig.5.-(c), the housing transaction price changed to the negative direction by the shock of rent-price ratio and the change extent was the largest. The housing transaction price moved to the positive direction by the shock of coincident composite index. The housing transaction price showed a relatively bigger change extent on
the shock of the housing rent price compared to the shock of housing transaction price and the shock of the amount of housing supply; however, as time went by, the change extent became smaller. As seen in Fig.5.(d), the housing rent price showed the largest change extent in the positive direction for the shock of housing rent price. The housing rent price showed a substantial change extent in the positive direction for the shock coincident composite index compared to other variables. The housing rent price changed to the positive direction on the shock of rent-price ratio and the shock of construction cost. It changed
Comparison of the Results

Table 5. Comparison of the Results of Impulse Response (IR) for Period A and Period B

| No. | Comparison | Results |
|-----|------------|---------|
| 1   | IR of HTPI (Period A) | - The shock of rent-price ratio in general shows a negative relationship with a change in the housing transaction price. However, the shock of rent-price ratio should show a positive relation with the change of housing rent price, the result is a negative relation. The reason is that the change rate of the housing transaction price is relatively higher than the change rate of the housing rent price. - The shock of housing rent price shows a positive relation with the housing transaction price change. The reason is that, as housings in the space market are supplied through the asset market, the rise in housing rent price increases the asset demand. However, the shock of housing transaction price shows a negative relation with the change of housing rent price, though the extent is minimal. The reason is that a demand movement from the space market to the asset market occurs. |
| 2   | IR of HRPI (Period A) | - The shock of construction cost shows a positive relation with changes in housing transaction price and housing rent price in the FDW model; however, it shows a negative relation according to the result of the impulse response. Even the amount of housing supply increases with an improvement of the profit rate of construction companies attributed to construction cost decrease, period A is the active economy period; therefore, there is sufficient housing demand. Therefore, it is believed that the housing transaction price and the housing rent price can rise. - The shock of the amount of housing supply in general shows a negative relation with the change in housing transaction price and housing rent price; however, it shows a positive relation according to the impulse response result. In the active economy period A, the equilibrium condition between supply and demand in the housing market is not continuously maintained. - The shock of coincident composite index has been found to be the same as the relation between the changes in housing transaction price/housing rent price and the relation on the FDW model. |
| 3   | IR of HTPI (Period B) | - In period B, the shock of housing transaction price also shows a negative relation with changes in housing rent price. The reason is that the space demand did not move to the asset demand because of the recession. - The shock of construction cost shows a positive relation with the change in housing transaction price in the FDW model; however, the result shows a negative relation. The reason is that, in the case of period B, investment demand had decreased; therefore, the decrease in construction cost does not increase the amount of housing supply. |
| 4   | IR of HRPI (Period B) | - The shock of the amount of housing supply should show a negative relation with housing transaction price change in the FDW model; however, it shows a positive relation according to the result of the impulse response. The reason is that, in the case of period B, the demand has already decreased due to recession. - The shock of the amount of housing supply should show a negative relation with the change in housing transaction price in the FDW model; however, it shows a positive relation in accordance with the result of the impulse response. The reason is that, in the case of period B, the demand has already decreased due to recession. - The shocks of housing rent price and coincident composite index have a general relation with the changes in housing transaction price and housing rent price. |
| 5   | IR of HTPI (Period A) | - The change extent of housing transaction price by the shock of coincident composite index is relatively larger in period B than in period A. - In general, the change extent of housing transaction price by the shock of variables is smaller in period B than in period A. The reason is that the housing economy is also in recession due to the recession in macroeconomics. |
| 6   | IR of HRPI (Period A) | - The change extent of housing rent price by the shock of coincident composite index is relatively larger in period B than in period A. |
| 7   | IR of HTPI (Period B) | - The change extents of housing rent price by the shock of variables do not have a large difference between period A and period B. The reason is that the space demand did not move to the investment demand and remained in the space market. |
| 8   | IR of HRPI (Period B) | - The change extent of housing rent price by the shock of variables do not have a large difference between period A and period B. The reason is that the space demand did not move to the investment demand and remained in the space market. |

Fig.5. Impulse Response Graph

to the negative direction by the housing transaction price and amount of the housing supply. Table 5. is the comparison of results of the impulse response for period A and B. Results 1 and 2 are a comparison of impulse response for individual markets, during the same period. Results 3 and 4 are a comparison of the impulse response for an individual period, for the same market.
5. Conclusion
The dynamics between the various factors in the housing market system are changing differently from one another, depending upon the macroeconomic fluctuations of the markets such as the rental market and the transaction market. This study is intended to conduct a comparison between the Korean transaction market and the rental market dynamics change before and after the macroeconomic fluctuations based on the the FDW model. In the results of comparison, characteristics, which are different from the dynamics between variables that are intuitively confirmed in the FDW model, were revealed. Specifically, when the results of variance decomposition and the results of impulse response were compared for each period and each market, some particular parts appeared in the dynamic relations between the variables and the explanation capacity of a variable on the change of other variables. It is believed that these results will be very meaningful from various perspectives, including the political and business points-of-view. Since the dynamics between variables are different from each other depending upon the market and the macroeconomic fluctuations, it is judged that the establishment of a business strategy and policy direction will be required according to each situation considering the differences in dynamics. The major contribution of this research addresses the fact that multiple supporting administrative policies by the government are required in order to boost housing demand such as by decreasing interest rates, reducing the housing transaction barrier, and tax policy, because housing demands are not related to housing transactions in the current Korean market.

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