Abstract
The phenomenon of unsold new housing stocks is an important indicator in the housing market system; it is directly related to the profitability of the construction business and appears as a result of an imbalance in the demand and supply of houses. Changes in demand-supply because of various factors are another phenomenon that occurs in the housing market. It is considered that these changes in demand-supply are closely related to the unsold new housing stocks. Therefore, we analyze the relationship between demand-supply in the housing market and unsold new housing stocks using the vector error correction model. We used data from Seoul as the spatial scope of this study, and the temporal scope of time series data ranged from July 2001 to July 2009. To obtain the time series data, databases of the Ministry of Land, Transport and Marine Affairs, Statistics Korea, CERIK, and Kookmin Bank were utilized. The results of variance decomposition analyses indicated that for changes in unsold new housing stocks, the explanatory powers of housing selling price indexes and housing loans were high while the explanatory powers of production factors were relatively low. Based on the results of impulse response analyses, the quantity of unsold new housing stocks showed larger changes in response to the impulses of housing prices and housing loans than to the impulse of production factors. Also, it was indicated that, among the production factors, unsold new housing stocks showed a pattern of continued change in relation to the financing status of suppliers while showing impromptu responses to the impulses of the material or manpower situation but no continued change.

Keywords: housing demand; housing supply; unsold new housing stocks; vector error correction model

1. Introduction
According to data published by the Construction & Economy Research Institute of Korea (CERIK), the transition of the general construction business BSI showed a continued drop from 80p in December 2006 to 14.6p in November 2008; the level of stagnation in the housing sector, in particular, was the most serious. In addition, the quantity of unsold new housing stocks across the country during the same period showed a value of over 100,000. As such, the housing market and unsold new housing stocks are closely related with each other.

Unsold new housing stocks refer to housing stocks that have been offered for sale but were not applied for and thus sales contracts were not made. These unsold new housing stocks exemplify the current situation of the housing market and are very important since they can seriously affect the financial conditions of construction businesses.

These unsold new housing stocks send signals about market trends to participants of the housing property markets. For instance, if there are large quantities of unsold new housing stocks, housing construction businesses delay housing supply and investors in real estate delay purchase decision making. On the other hand, if the quantities of unsold new apartment stocks are reduced, this seems to elicit an increase in apartment prices, urging housing supply companies to increase construction and investors to withdraw the real estate offered for sale from the market. Overall, unsold new housing stocks work as an important market indicator for demand-supply. That is, since the demand-supply in the housing market changes because of various factors and the occurrence of unsold new housing stocks is also an important phenomenon that occurs under the housing market system, it is considered that the demand-supply in the housing...
market and unsold new housing stocks are closely related.

Nevertheless, increase/decrease in the quantity of unsold new housing stocks is only considered as a vague index to judge housing businesses, and no study has to date reviewed the relationship between unsold new housing stocks and the housing market.

Therefore, this study analyzes the relationship between demand-supply in the housing market and unsold new housing stocks using the vector error correction model (VECM). We used data from Seoul, the capital of Korea, as the spatial scope of this study, and the temporal scope of time series data ranged from July 2001 to July 2009. The time series data was obtained from databases of the Ministry of Land, Transport and Marine Affairs, Statistics Korea, CERIK, and Kookmin Bank. The data collected was monthly data, and was log-transformed to be used as analysis variables.

2. Literature Review

Although unsold new housing stocks are important indexes to show the situation of the housing market and determine the financial soundness of the construction business, studies on unsold new housing stocks are limited. Arnott (1989) elucidated that empty houses serve a socially desirable function in that they expand the width of selection to households entering the housing market. He, however, based his study on mathematical models and did not conduct empirical analyses. Other studies on the housing market are focused on demand-supply and pricing, as shown in Table 1.; most of them consider unsold new housing stocks to be a serious problem, but in-depth study has not been conducted in this regard.

3. Fisher-Dipasquale-Wheaton (FDW) Model

In this study, we analyze the relationship between unsold new housing stocks and demand-supply based on the Fisher-Dipasquale-Wheaton (FDW) model—a quadrant model that defines the demand-supply balance in real estate markets and tracks the relationship between space and property markets. The FDW model conceptually assumes that real estate development will occur when revenues are created from demands in the demand-supply imbalance in the space markets. That is, demand for real estate spaces will increase in relation to changes in the macroscopic economy such as in the interest rates as well as the economic growth and market liquidity. Further, if the value of real estate as properties can realize revenues, development will occur and balanced prices will be established in the space market in the long run. There are two main links between property and space markets. First, the level of rent in the space market determines the demand for real properties. It is like the case of investors who buy property considering present or future revenues. That is, changes in rent in the space market will immediately affect property demand in the capital market. Second, construction volumes are an important link between these two major markets. If construction volumes increase, not only prices in the property market but also rent in the space market will go down. These relationships between space markets and property markets are shown in the following quadrant model.

In summary, the space market determines the rent and the rent is in turn converted to individual spaces by the property market. On the other hand, property prices induce new construction volumes and thereby they return to the space market to result in housing stocks. The space and property markets are linked such that they maintain equilibrium when the quantity of housing stocks does not change. If the quantity after a cycle is completed is different from the initial quantity, it means that equilibriums are not maintained among the four variables in the FDW model.

4. Empirical Procedure

In this study, variables were selected based on the FDW model explained above. Since unsold new

| Researchers   | Main contents                                                                 |
|---------------|-----------------------------------------------------------------------------|
| Follain (1979) | Examines whether the demand for the structural component of new housing has exerted an upward influence on the long-run price of housing |
| Arnott (1989) | Presents a model with rental housing vacancies in equilibrium                 |
| Green et al. (1996) | Measures the impact of age structure, education and income on the willingness of households to pay for constant quality housing |
| Blackley (1999) | Investigates the long-run elasticity of new housing supply in the United States |
| Malpezzi et al. (2001) | Estimates the price elasticity of housing supply from new constructions separately for the United States and the United Kingdom |
| Riddel (2004) | Develops a disequilibrium housing-market model that separates disequilibrium generated by supply disturbance from that arising from demand disturbance |
| Mayer et al. (2004) | Presents an empirical model of housing supply derived from the urban growth theory |
| Sing et al. (2006) | Empirically tests the house price dynamics associated with the mobility of households in the public resale, private resale, and private housing markets in Singapore |
| Glaeser et al. (2008) | Presents a simple model of housing bubbles that predicts that places with more elastic housing supply have fewer and shorter bubbles, with smaller price increases |
| Oikarinen (2009) | Empirically examines if household borrowing data, indeed, is of importance in a dynamic housing price model |
housing stocks ($W_t$) are directly related with newly offered houses, they are determined by functions of demand ($DN_t$) and supply ($SN_t$) of newly offered houses.

$$W_t = f(DN_t, SN_t)$$

where $W_t$ denotes the unsold new housing stocks in period $t$; $DN_t$, the demand for new houses; and $SN_t$, the supply of new housing.

The demand for houses can basically be divided into demand for new houses and demand for housing stocks. Therefore, buyers determine whether to acquire new houses or housing stocks depending on their income level or loan limits with each. In addition, macroscopic economy and housing policy situations also affect housing purchase decisions but these factors are reflected in the prices under the FDW model. With regard to the ability to buy houses, most buyers purchase houses with loans, where the loan amount is proportional to the income level. Therefore, in this paper, the demand for new houses ($DN_t$) was defined as a function of new house prices ($PN_t$), housing stock prices ($PS_t$), and housing loans ($Y_t$):

$$DN_t = f(PN_t, PS_t, Y_t)$$

As identified in the third quadrant of the FDW model, new housing supply is determined by whether the supply would be profitable when comparing new housing prices and construction costs. Therefore, in this study, new housing supply was defined as a function of new housing prices and construction costs ($C_t$):

$$SN_t = f(PN_t, C_t)$$

In the case of Korea, since there is no time series data on new housing prices, these are replaced by other variables. Since new housing prices ($PN_t$) are generally calculated based on the prices of previously built houses in the vicinity, they were defined as a function of housing stock prices ($PS_t$).

$$PN_t = f(PS_t)$$

In the case of Korea, although there are Construction Cost Indexes, time series data are limited, and thus they are insufficient for analyses. Therefore, we defined construction costs ($C_t$) as a function of funds ($I_t$), materials ($M_t$), and manpower ($L_t$).

$$C_t = f(I_t, M_t, L_t)$$

When these are summarized comprehensively, unsold new housing stocks ($W_t$) are defined as follows:

$$W_t = f(PS_t, I_t, M_t, L_t, Y_t)$$

Time series graphs between unsold new housing stocks and individual variables were reviewed. First, based on a review of the housing transaction price index graph indicating unsold housing stocks and housing stock prices, the quantity of unsold new housing stocks increased greatly due to the housing market that has been very dull since the period of the IMF at the end of 1997, but the quantity of unsold new housing stocks began to decrease rapidly owing to specific policies intended to boost businesses.

However, the quantity of unsold new housing stocks increased rapidly since the change of regime because of the policy intended to control the housing market, and recently, it spiked due to changes in the macroscopic economy resulting from the global financial crisis. Although the housing transaction price index shows continuous increasing trends, it can be identified that the increasing trends became lower when the quantity of unsold new housing stocks increased.
The graph of unsold new housing stocks and construction costs, i.e., production factors, is reviewed as follows.

The time series data on the production factors utilized in this paper were obtained by utilizing the BSIs by factors announced by the Construction & Economy Research Institute of Korea; and higher indexes mean a smoother supply of production factors. When reviewing the related graph, it can be identified that although unsold new housing stocks show decreasing trends when funds are being smoothly supplied, no particular relationship exists between material or manpower supply situations and unsold new housing stocks.

The graphs of unsold new housing stocks and housing loans are reviewed below.

Except for the time when the housing market was dulled by the aftermath of the global financial crisis, housing loans generally show increasing trends. Also, when the quantity of unsold new housing stocks was increasing, the increasing trend showed decreasing patterns.

When conducting series analyses, the stability of series data should be secured. If the analyses have been conducted utilizing unstable series data, a phenomenon of spurious regression occurs that shows the existence of correlations in semblance even if there is no correlation between variables.

To test this, the existence of unit roots should be checked, and if unit roots exist, the series data are not stable. Therefore, we applied the augmented Dickey-Fuller (ADF) method, which is a representative unit root test method, to conduct unit root tests.

First, ADF tests were conducted on the level variables obtained by log-transforming individual variables. On the basis of the result, we could not reject the null hypothesis that all variables except for Mt and Lt had unit roots at the 5% significance level. The level variables were then differentiated once and the ADF tests were conducted. On the basis of the result, we could reject the above null hypothesis at the 5% significance level.

If the individual variables introduced for analyses are unstable, linear combinations of the variables may have stable characteristics. That is, when unstable time series data are transformed into stable variables through differentiation processes, a problem of losing the information on long-term changes that had been included in the raw data may occur. To check this, cointegration tests should be conducted. If no cointegration exists based on the results of the cointegration tests, the vector auto regression model (VARM) should be utilized, and if any cointegration does exist, the VECM should be utilized. Therefore, in this paper, the Johansen tests, which are representative cointegration tests, were conducted. However, Boswojk (1996) reported that if time differences were set to be too short, there would be a tendency to reject the null hypothesis and that there would be no cointegration, while if they were too long, a problem of weakened testing power would appear. Therefore, in this study, time differences were tested based on SIC and the result; an appropriate lag order of 1 was selected.

Cointegration tests were conducted through the lag order and based on the result, the null hypothesis that there was no cointegration could be rejected at the 5% significance level; the results showed at least two
Therefore, in this study, analyses were conducted using the VECM.

5. Empirical Results

The VECM is a method that can improve some problems of the VARM and it is related to the concept of cointegration (Eagle and Granger, 1987). Most economy variables are unstable time series and if these unstable time series have cointegration relationships, the series variables will come to have long-term balanced relationships with each other, and it will become possible to test their dynamic structural relationships using the VECM.

First, for changes in the quantity of unsold new housing stocks, the housing selling price indexes showed a continuous increase of explanatory power for up to 10 months, reaching 8.77%. When part of production factors was reviewed, for changes in the quantity of unsold new housing stocks, all the Funding BSI, Material BSI, and Labor BSI showed a continuous increase in the explanatory power for up to 10 months, reaching 1.82%, 0.13%, and 1.03%, respectively.

Finally, for the effect of housing loans on changes in the quantity of unsold new housing stocks, its explanatory power continuously increased for up to 10 months, reaching 5.00%.

Impulse-response analyses have previously been used to identify the degree of change of a variable in a model and other variables during a certain time when the impulse of one standard deviation is applied, to analyze correlations between the variables and ripple effects. In this study, through impulse-response analyses, the behavior of the quantity of unsold new housing stocks was analyzed when a certain impulse was applied to individual variables such as housing selling price indexes, Funding BSI, Material BSI, Labor BSI, and housing loans.

When the course of change in the quantity of unsold new housing stocks related with the impulse of one standard deviation on individual variables was reviewed, the size of change in the quantity of unsold new housing stocks continuously increased in the negative direction with respect to the impulse of housing selling price indexes, with a 0.17% change at the final time point of 10 months.

### Table 3. Lag Specification Results for Cointegration Tests

| Lag | AIC     | SIC     | HQ     |
|-----|---------|---------|--------|
| 0   | -14.84722 | -14.67831 | -14.77917 |
| 1   | -15.97180* | -14.78943* | -15.49545* |
| 2   | -15.90351 | -13.70769 | -15.01887 |
| 3   | -15.64231 | -12.43304 | -14.34938 |
| 4   | -15.43529 | -11.21255 | -13.73405 |
| 5   | -15.15833 | -9.922137 | -13.04880 |
| 6   | -15.02798 | -8.778333 | -12.51015 |
| 7   | -14.84085 | -7.577751 | -11.91473 |
| 8   | -15.23761 | -6.961053 | -11.90319 |

- Significant at 5% level
- r is cointegration rank

### Table 4. Cointegration Test Results

| Null hypothesis | Test statistic | 0.05 Critical Value | p-value |
|-----------------|----------------|---------------------|---------|
| r = 0*          | 249.3709       | 103.8473            | 0.0000  |
| r ≤ 1*          | 84.18350       | 76.97277            | 0.0127  |
| r ≤ 2           | 44.27428       | 54.07904            | 0.2770  |
| r ≤ 3           | 28.20498       | 35.19275            | 0.2323  |
| r ≤ 4           | 16.61843       | 20.26184            | 0.1474  |
| r ≤ 5           | 7.550089       | 9.164546            | 0.1003  |

- Significant at 5% level
- r is cointegration rank

### Table 5. Variance Decomposition

| Period | $W_t$ | $PS_t$ | $I_t$ | $M_t$ | $L_t$ | $Y_t$ |
|--------|-------|--------|-------|-------|-------|-------|
| 1      | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2      | 98.51575 | 0.565826 | 0.028310 | 0.074690 | 0.024779 | 0.790644 |
| 3      | 96.83944 | 1.548991 | 0.146758 | 0.053142 | 0.017514 | 1.394153 |
| 4      | 94.87509 | 2.726991 | 0.355214 | 0.043568 | 0.044533 | 1.954601 |
| 5      | 92.80579 | 3.913782 | 0.600461 | 0.047311 | 0.131785 | 2.500873 |
| 6      | 90.72648 | 5.047966 | 0.856922 | 0.058868 | 0.265924 | 3.043843 |
| 7      | 88.70435 | 6.104135 | 1.112071 | 0.074911 | 0.432850 | 3.571687 |
| 8      | 86.77450 | 7.075012 | 1.359266 | 0.093221 | 0.621595 | 4.076409 |
| 9      | 84.95485 | 7.961268 | 1.594654 | 0.112383 | 0.823057 | 4.553784 |
| 10     | 83.25241 | 8.767657 | 1.816328 | 0.131543 | 1.030067 | 5.001990 |
In relation to the impulse of Funding BSI, the size of changes in the quantity of unsold new housing stocks continuously increased in the negative direction, with a 0.08% change at the final time point of 10 months.

On the other hand, the size of the change in the quantity of unsold new housing stocks in relation to the impulse of Material BSI or Labor BSI showed a different pattern compared to the impulse of Funding BSI. That is, in relation to the impulse of Material BSI, the size of the change in the quantity of unsold new housing stocks showed a change of around 0.02% in the negative direction at the time point of 2 months, but again changed in the positive direction from the time point of 3 months, with a 0.02% change at the final time point of 10 months. Similarly, in relation to the impulse of Labor BSI, the size of the change in the quantity of unsold new housing stocks showed a change of around 0.009% in the negative direction at the time point of 2 months and around 0.002% at the time point of 3 months, but changed to the positive direction from the time point of 4 months, with a change of 0.07% at the final time point of 10 months.

The size of the change in the quantity of unsold new housing stocks continuously increased in the negative direction in relation to the impulse of housing loans, with a 0.13% change at the final time point of 10 months.

That is, the quantity of unsold new housing stocks showed larger changes in relation to the impulse of housing prices or housing loans than in relation to production factors. It was indicated that among the production factors, continued changing patterns were shown in relation to the situation of funding of suppliers, while impromptu responses were shown for the impulse of materials or manpower situations, where the responses were not continuous.

6. Conclusion

The phenomenon of unsold new housing stocks is an important indicator in the housing market system; it is directly related to the profitability of the construction business and appears as a result of an imbalance in the demand and supply of houses. However, studies on the empirical analyses of this phenomenon are limited. Therefore, in this study, we analyzed the dynamic relationship between the quantity of unsold new housing stocks and housing markets based on the FDW model.

Unit root analyses were conducted before the analyses. Based on the results, it was identified that the variables except for Material BSI and Labor BSI were unstable time series having unit roots. They were differentiated and re-tested and the result indicated that none of the variables had any unit root. Analyses of appropriate time differences were conducted before cointegration tests and based on the result, lag order 1 based on SIC was judged to be an appropriate time difference. Cointegration analyses were conducted utilizing the lag order. Based on the results, linear relationships, i.e., cointegration, were found between variables, and accordingly the VECM was established.

Empirical analyses were conducted based on the

![Graphs](image1)

Fig.5. Variance Decomposition
VECM. Analyses of decomposed variance were conducted first and based on the results, it was indicated that, for changes in the quantity of unsold new housing stocks, the explanatory powers of housing selling price indexes and housing loans were high while those of production factors such as Funding BSI, Material BSI, and Labor BSI were relatively low. This result eventually means that the degree of occurrence of unsold new housing stocks is affected more by formed housing prices and housing demands than by the production costs considered by construction companies when supplying new houses. That is, if the housing market is active, profitability can be secured even if production costs increase.

Based on the results of impulse-response analyses, the quantity of unsold new housing stocks showed larger changes in relation to the impulse of housing prices or housing loans compared to production factors. Also, it was indicated that, among the production factors, continuous changing patterns were shown in relation to the situation of funding of suppliers while impromptu responses were shown in relation to the impulse of materials or manpower situations, but the responses were not continuous. Based on these results of analyses, it is necessary to perceive that sudden enforcement of housing policies that affect both housing demand and supply may eventually cause the occurrence of unsold new housing stocks, thereby seriously affecting the management of the construction business.

Table 6. Impulse Response

| Period | \(W_t\) | \(PS_t\) | \(I_t\) | \(M_t\) | \(L_t\) | \(Y_t\) |
|--------|---------|---------|--------|--------|--------|--------|
| 1      | 0.438816 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2      | 0.358159 | -0.042927 | -0.009602 | -0.015596 | -0.008983 | -0.050743 |
| 3      | 0.371964 | -0.074178 | -0.024570 | 0.002958  | -0.001533 | -0.063529 |
| 4      | 0.367010 | -0.099816 | -0.039085 | 0.004553  | 0.013990  | -0.074996 |
| 5      | 0.367338 | -0.116901 | -0.049920 | 0.009941  | 0.027499  | -0.086051 |
| 6      | 0.367069 | -0.131577 | -0.058659 | 0.013740  | 0.038681  | -0.096604 |
| 7      | 0.367465 | -0.143698 | -0.066023 | 0.016815  | 0.048376  | -0.105944 |
| 8      | 0.367066 | -0.153893 | -0.072338 | 0.019343  | 0.056964  | -0.114150 |
| 9      | 0.367119 | -0.162569 | -0.077778 | 0.021446  | 0.064548  | -0.121372 |
| 10     | 0.367188 | -0.170026 | -0.082486 | 0.023219  | 0.071217  | -0.127734 |

Fig. 6. Impulse Response Function
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