Panel Analysis of Relationship between House Sales Prices and Trading Volume*

패널자료에 기초한 주택 실거래가격과 주택 거래량의 관계분석

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국문초록

1. 내 용

(1) 연구목적

본 연구는 패널 분석에 기초하여, 2006~2015년 동안 우리나라 15개 지역의 아파트 실거래가격과 거래량의 관계 분석을 목적으로 하고 있다.

(2) 연구방법

본 연구는 CIPS 패널단위근 검정법에 기초하여 공적분 검정을 시행하였으며, 단기뿐만 아니라 장기에 있어서 패널 인과관계를 시행하였다. 또한 고정효과 및 확률효과 모형 그리고 패널 ARDL 모형을 이용하여 가격과 거래량과의 관계를 분석하였다.

(3) 연구결과

본연구의 실증 결과에 의하면, 전체 15개 지역의 주택가격은 거래량과 장기적으로 공적분 관계에 있는 것으로 나타났다. 또한 주택가격과 거래량은 단기와 장기에 있어서 모두 양방향 인과관계가 성립하는 것으로 나타났다. 패널 추정결과에 의하면 거래량은 주택가격에 영향을 주며 또한 반대의 경우도 성립한다. 공적분, 인과관계 및 패널 추정결과는 주택가격과 거래량만을 포함한 두 변수 모형뿐

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만 아니라 거시경제변수를 외생변수로 포함하는 모형에서도 같은 결과를 보이고 있다.

2. 결 과

본 연구결과에 의해 주택가격과 거래량은 서로 정(+)의 관계를 가짐으로써 두 변수 간에는 동조화 현상을 보이는 것으로 나타났다. 특히 장단기 모두 거래량이 가격에 미치는 영향보다 가격이 거래량에 미치는 영향이 훨씬 더 큰 것으로 나타났다. 이는 주택시장의 움직임에 있어서 거래량보다 가격이 더 중요한 요인이라는 것을 의미한다. 이러한 동조화 현상은 연구기간 동안 국내 주택시장 및 경제상황을 고려할 때, 예산제약모형보다는 손실회피모형에 의한 설명이 보다 현실적이라고 판단된다.

3. 핵심어

• 패널 단위근, 패널 공적분, 패널 오차수정모형, 주택 실거래가격, 주택거래량

ABSTRACT

The purpose of this paper is to verify and estimate the relationship between the house sales prices and trading volume during 2006~2015 in Korean housing markets. The empirical results show that, based on the panel causality test with error correction term, there exist short-run and long-run bidirectional causal relationships between house sale prices and trading volume. In addition, using both the fixed effect and random effect model and ARDL model, we find that the positive effect of house prices on trading volume is larger than that of the trading volume on the house prices in the short run as well as in the long run. This positive correlation between the two variables can be explained by the theory of loss aversion, considering the features of Korean housing markets and macroeconomic situations during the whole sample period.

KEY WORDS : Panel unit root, Panel cointegration, Panel VECM, House sales prices, House trading volume

Ⅰ. Introduction

Many countries including Korea have experienced the housing market downturn followed by both a sharp drop in house prices and large decrease in trading volume, due to the aftermath of a burst of housing bubble and subsequent financial crisis in 2006 in US. This leads to a recession of world economy. Specially, the changes in house prices and sales volume significantly affect the economic activity of participants surrounding the housing markets. In this context, the importance of both economic and policy implications from the changes in house prices and trading volume has been magnified during last decades.

Nevertheless, the relationship between prices and trading volume has been analyzed for longer time in the literature of financial markets rather than property markets. For instance, Lucas (1978)[1], based on the theory of efficient market and rational expectation, demonstrates that there will be no correlation between the trading volume of an asset and the corresponding prices if the equally informed agents are rational, the capital market is perfect, and the market is centralized. However, a number of empirical studies find evidence showing a positive price-volume correlation in the financial markets.

The positive relationship between prices and trading volume has been also found later in the literature of property markets, and thus the positive relation is not consistent with the standard rational expectation asset market models as well. Rather, the features of less efficient and imperfect real estate markets appear to generate the accumulating evidence of positive price-volume correlation. Specially, a positive correlation would be caused by the characteristics of real estate market such as equity constraints, nominal loss aversion, and information friction.

Although the previous studies suggest empirical findings that help our understanding of the dynamics of positive price-volume correlation, some important aspects regarding this issue are not well understood. For instance, the empirical evidence regarding the relationship between house prices and trading volume is usually based on the aggregate national or regional data. Therefore, whether the house price-volume correlation is observed in a specific market or across markets is an important question to be answered. Second, does the causal relation from prices to trading volume exist across Korean housing markets? If so, how and to what extent do the house prices influence the trading volume? Third, housing markets play an important role in the economy. In this regard, is the house price-volume correlation solely due to the causal relation between the two variables or due to the reaction of additional economic variables such as price level, national production, and interest rate? Considering these features, this paper aims to investigate the relationship between prices and trading volume in 15 Korean housing markets.

II. Related Literature

Accumulating empirical evidence demonstrates the positive correlation between trading volume and the price in real estate markets. Among these researches, three seemingly related, but

1) Lucas, R., "Asset prices in an exchange economy", *Econometrica*, 1978, Vol.46, pp.1429-1445.

competing, theories have been proposed.

The first view is housing equity constraints (or downpayment requirement), which is developed by Stein (1995)[2] and is the foundation for much of the empirical work such as Chan (2001)[3], among others. Stein (1995)[4], using US-wide volume and median real sales prices for single-family homes during 1968~1992, reports evidence of positive relationship between trading volume and percentage change in house prices. Stein (1995)[5] analyzes that this positive correlation stems from the downpayment. Since most of home buyers are mortgage-financed and the mortgage loan is only part of the house price, the remainder of the house price is generally covered by the equity of the buyers. Accordingly, when house price falls, the equity of homeowners decreases and this results in equity (or downpayment)- constrained homeowners. Therefore, the homeowners are not likely to move because they can only afford a smaller unit now for new houses. This leads to a fall in market demand for housing (and trading volume) and to a subsequent decrease in house price. Consequently, a positive correlation is generated.[6]

Second theoretical view in supportive of the positive relationship between trading volume and house price is known as a model of nominal loss aversion and is first analyzed by Genesove and Mayer (2001)[7] in the housing market. Engelhardt (2003)[8] provides empirical evidence for the presence of loss aversion behavior on the part of potential sellers in the housing markets. The basic idea of loss aversion starts the notion of asymmetrical treatment of gains and losses by homeowners. In other words, the homeowners are reluctant to realize nominal losses. Thus, when they sell their houses, they set higher prices and have longer time on the market in the hope that a buyer will offer a price that is high enough to mitigate the nominal loss.

The third theoretical view for the positive price-volume correlation is developed by Berkovec and Goodman (1996).[9] This view focuses on the information friction of the housing market. In the model of Berkovec and Goodman (1996)[10], the housing trade

2) Stein, J. C., 1995, ibid

3) Chan, S., "Spatial lock-in: Do falling house prices constrain residential mobility?", *Journal of Urban Economics*, 2001, Vol.49, pp.567-586.

4) Stein, J. C., 1995, ibid

5) Stein, J. C., 1995, ibid

6) Likewise, a positive relationship between trading volume and price can be also generated when house price increases. That is, a rise in house price increases the equity of homeowners and thus enables them to afford the downpayment requirement for new houses, leading to an increase in trading volume.

7) Genesove, D. and C. J. Mayer, 2001, ibid.

8) Engelhardt, G. V., "Nominal loss aversion, housing equity constraints, and household mobility: evidence from the United States", *Journal of Uran Economics*, 2003, Vol.53, pp.171-195.

9) Berkovec, J. A. and J. L. Goodman, 1996, ibid.

occurs only when the sellers offer the price which is equal to or below the buyer's reservation price. Otherwise, sellers adjust to lower price because sellers need to sell their houses within a certain period time, and buyers further search other house with lower prices. When there is a negative demand shock in the housing market, the number of unsold houses rises and thus the trading volume decreases in the following period, leading to a lower price. As a result, this generates a positive price-volume correlation.

On the other hand, a few studies have empirically performed to investigate the issue of price-volume correlation in Korean housing markets. The study of Kim and Yu (2013)[11] finds that seller and buyers have discrete selling and buying time preference which affect the relationship between and trading volume. They find evidence of positive interrelation between these two variables in five Korean region. Lim(2014)[12] finds one-way or two causal relationship between prices and trading volume, depending on the regions. He also show that acquisition tax reduction policy has a positive influence on trading volume.[13]

III. Empirical Results

The model is estimated using monthly data series ranging from 2006:01 through 2015:03. Our sample gathers 15 regions' house sales price indexes and trading volume.[14] The 15 regions include Seoul, Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan, Gyeonggi, Gangwon, Chungbuk, Chungnam, Junbuk, Junnam, Gyungbuk, and Gyungnam. The house sales prices and trading volume series are obtained from the Onnara Real

10) Berkovec, J. A. and J. L. Goodman, 1996, ibid.

11) Kim, D. W. and J. S. Yu, "How selling-buying time preference affects on forming the relationship between housing price and trading volume", *Korea Real Estate Academy Review*, 2013, Vol.54, pp.229-243.

12) Lim, D. B. "The research on housing transaction volume and housing prices- with focus on local taxes(acquisition tax)", *Korea Real Estate Academy Review*, 2014, Vol.55, pp.195-208.

13) In addition, there are a few studies using house sales price in Korean housing markets as follows: Lee, J. S. and C. H. Lee, "Analysis on the determinants of Korean housing price index in unstable housing market by volatility of the housing price", *Korea Real Estate Academy Review*, 2014, Vol.59, pp.203-216; Chung, J. H. and H. S. Yoo, "The dynamic relationship between apartment price index and private consumption", *Korea Real Estate Academy Review*, 2014, Vol.59, pp.139-149; Jung, E. J. and K. W. Yi, "A study on the estimation of minimum volume to maintain liquidity in housing market", *Korea Real Estate Academy Review*, 2014, Vol.56, pp.248-261.

14) This paper proposes panel log-linear models to examine the relationship between regional house prices (HPI) and trading volume (VOL), based on either fixed effect or random effect specifications as follows.

$$\ln HPI_{it} = \mu_{i0} + \eta_{t0} + \alpha_1 \ln VOL_{it} + \alpha_2 \ln CPI_{it} + \alpha_3 \ln IP_{it} + \alpha_4 IR_{it} + \alpha_5 \ln STOCK_{it} + \epsilon_{it}$$

$$\ln VOL_{it} = \mu_{i1} + \eta_{t1} + \beta_1 \ln HPI_{it} + \beta_2 \ln CPI_{it} + \beta_3 \ln IP_{it} + \beta_4 IR_{it} + \beta_5 \ln STOCK_{it} + u_{it}$$

, where $\ln HPI_{it}$, $\ln VOL_{it}$, $\ln CPI_{it}$, $\ln IP_{it}$, IR_{it}, $\ln STOCK_{it}$ are the house prices, trading volume, consumer price index, industrial production index, interest rate and KOSPI in the log form, except for interest rate, respectively. The subscript it denotes ith region of the 15 panels at time t. μ_i represents the cross-section specific effect which captures the time invariant individual heterogeneity (i.e. regional fixed effect). η_t is a time dependent intercept, which captures the time-varying national-level (or common) effects on the two endogenous variables.

Estate Information Portal Service supported by Ministry of Land, Infrastructure and Transport.[15] The data for consumer price index (CPI), industrial production index (IP), interest rate (IR, yield rate of three year maturity corporate bond), and stock price index (KOSPI) are drawn from the Bank of Korea. All the series, but interest rates, are defined as the natural logarithm.

1. Unit Root Test

The conventional panel unit root tests are known to have the problem of serious size distortion facing with the cross-section dependence (e.g., Phillips and Sul, 2003).[16] Regarding this, we first perform cross-section dependence (CD) test proposed by Pesaran (2004)[17] to see if the residuals of the ADF regression are cross-sectionally independent. The results are shown in ⟨Table 1⟩. The CD statistics are all significant at the 1% level, indicating strong dependence in house price and trading volume series in levels.

Allowing for cross-sectional correlation, we employ a panel unit root test proposed by Pesaran (2007)[18]. As shown in ⟨Table 2⟩, the unit-root hypothesis is not rejected at 1% level based on the CIPS statistics. Meanwhile, we are able to reject the joint unit root null hypothesis at the 1% levels of significance when we consider the first difference of levels of the variables. Thus, it could be said that the two series in panel are integrated of order one (i.e., I(1)).

⟨Table 1⟩ Diagnostic test for cross-section dependence

CD:	HPI	VOL
lag		
1	33.10***	32.76***
3	35.76***	42.62*** (3)
5	37.01*** (5)	44.27***
7	36.27***	38.77***
9	36.94***	34.87***

Notes: CD denotes cross-sectional dependence test of Pesaran (2004). *** denotes significance at the 1% level and the rejection of cross-section independence. The numbers in parentheses are optimum lag selected by AIC in each series.

⟨Table 2⟩ Panel unit root test

	HPI	VOL
Level		
CIPS	-2.023	-2.356
First difference		
CIPS	-9.751***	-8.783***

Notes: 1. The equations for CIPS test include an intercept, a trend, the first lags of difference of the dependent variable, the difference of the cross section-mean and the cross-section mean. The critical values for CIPS come from Pesaran (2007) Table II(c), page 281: -2.92 for 1%, -2.75 for 5%, -2.66 for 10%. The null hypothesis is that of a unit root and the alternative hypothesis is that at least one of the series is stationary. 2. *** denotes significance at 1% level.

15) Since the trading volume data series is provided as a form of rate of turnover (or rate of change), the raw data series itself without transforming is used, for instance, in case of equation (10). Otherwise, we transform the series into the form of accumulation, for instance, in the cases of unit root test, cointegration test and long-run estimation.

16) Phillips, P. C. B. and D. Sul., "Dynamic panel estimation and homogeneity testing under cross section dependence", *Econometrics Journal*, 2003, Vol.6, 217-260.

17) Pesaran, M. H., 2004, ibid.

18) Pesaran, M. H., 2007, ibid.

⟨Table 3⟩ Individual unit root test

	Level		First difference	
	ADF	PP	ADF	PP
CPI	-0.75	-1.07	-8.29***	-8.53***
IP	-2.75	-2.51	-7.86***	-7.82***
IR	-3.17*	-2.91	-7.92***	-7.95***
KOSPI	-2.20	-2.56	-9.37***	-9.42***

Notes: ***, **, and * denote significance at 1%, 5%, and 10% level, respectively.

2. Cointegration Test

Given that the series tested are integrated of order one, the natural next step is to test for cointegration in our panel framework. ⟨Table 4⟩ presents Pedroni's (2004)[19] rho, the panel and group statistics with different dependent variables in case of two-variable equations. Though not with all tests, we generally obtain strong evidence of integration between house prices and trading volume.

To check the robustness of the empirical results of Pedroni test, we also apply alternative cointegration tests developed by Kao (1999)[20]. As is clear from ⟨Table 4⟩, the Kao t statistics suggests the rejection of null hypothesis of no cointegration, confirming cointegrating relations between the two variables.

⟨Table 5⟩ documents the results of panel cointegration tests for the case of six-variable equations. For the Pedroni test, when the dependent variable is house price series, only three out of seven statistics indicate that the null hypothesis of no-cointegration is rejected. According to Pedroni (2004)[21], rho and PP tests tend to under-reject the null in the case of small samples which is the present case. Furthermore, Pedroni (2004)[22] shows that the panel-ADF and group ADF tests have

⟨Table 4⟩ Panel cointegration (two-variable)

Dependent variable	HPI	VOL
Pedroni test		
Panel ν-statistics	-1.86	5.04***
Panel rho-statistics	-5.26***	-12.45***
Panel PP-statistics	-6.97***	-19.79***
Panel ADF-statistics	-1.41*	-11.39***
Group rho-statistics	-2.81***	-10.54***
Group PP-statistics	-5.89***	-23.20***
Group ADF-statistics	1.51	-4.52***
Kao t statistics	1.68**	-1.94**

Notes: Pedroni statistics test the following hypothesis: H_0: All of the individuals of the panel are not cointegrated. H_1: A significant portion of the individuals are cointegrated. ***, **, and * denotes significance at 1%, 5%, and 10% level, respectively.

⟨Table 5⟩ Panel cointegration (six-variable)

Dependent variable:	HPI	VOL
Pedroni test		
Panel ν-statistics	-3.28**	4.32***
Panel rho-statistics	1.06	-8.01***
Panel PP-statistics	-1.15	-22.14***
Panel ADF-statistics	4.37***	-18.70***
Group rho-statistics	2.37	-7.77***
Group PP-statistics	0.25	-24.45***
Group ADF-statistics	4.88***	-12.12***
Kao t statistics	-1.97**	-3.20***

Notes: See notes in ⟨Table 4⟩.

19) Pedroni, P., 2004, ibid.

20) Kao, C., "Spurious regression and residual-based tests for cointegration in panel data." *Journal of Econometrics*, 1999, Vol.90, pp.1-44.

21) Pedroni, P., 2004, ibid.

22) Pedroni, P., 2004, ibid.

better small-sample properties than other tests, and hence, they are more reliable.

The Kao t statistics confirm the results of Pedroni test that suggest the rejection of null hypothesis of no-cointegration. Thus, it can be predicted that six variables tested move together in the long run. In other words, there is a long-run steady-state relationship among the variables.

3. Causality Test

〈Table 6〉 presents the causal relationships between house prices and trading volume without (and with) exogenous variables. The results of causality tests of 〈Table 6〉 are consistent with the results of cointegration in 〈Table 4〉 and 〈Table 5〉, following Granger representation theorem that if two or more variables are cointegrated, then at least one-way causality must exist in the system to take it towards equilibrium.

〈Table 6〉 Panel causality test

Dependent variable	Source of causation (independent variable)					
	Two variables			Six variables		
(a): short-run	ΔHPI	ΔVOL		ΔHPI	ΔVOL	
ΔHPI	-	5.40^{***}		-	9.21^{***}	
ΔVOL	15.1^{***}	-		8.94^{***}	-	
(b): Long-run	ECT	$ECT, \Delta HPI$	$ECT, \Delta VOL$	ECT	$ECT, \Delta HPI$	$ECT, \Delta VOL$
ΔHPI	-0.04^{***}	-	5.4^{***}	-0.07^{***}	-	9.98^{***}
ΔVOL	0.01^{*}		14.1^{**}	0.03^{*}	8.47^{***}	-

Notes: *** denotes significant at 1% level.

That is, evidence of two-way panel causality between house prices and trading volume can be observed in 〈Table 6〉 both in the short run and in the long run. As is clear, the coefficient of ΔVOL is significant at 1% level in ΔHPI equation, indicating that the short-run causality runs from house prices to trading volume in the cases of two and six variable models. The result is same in the ΔVOL equation, which means that there are short-run bidirectional causalities between house prices and trading volume. Therefore, whenever a shock occurs in the system, ΔHPI and ΔVOL would make short-run adjustments to restore long-run equilibrium, respectively.

In the panel (b) of 〈Table 6〉, since the four error correction terms (ECT) in both ΔHPI and ΔVOL equations are statistically significant, all variables have the critical impact on house prices and trading volume, respectively, which is in line with a theoretical expectation. Furthermore, interaction terms (ECT and ΔVOL in the HPI equation, and ECT and ΔHPI in the ΔVOL equation) can comprehensively determine strong causality among the variables in both equations in the long run.

4. Panel Estimation

Having established cointegration as well as the direction of causality in the long run, we estimate the long-run elasticity using the panel models.

In 〈Table 7〉, all the constant terms are statistically significant at the 1%

level. Therefore, the regional factors, especially related to the trading volume and house prices in our sample, differently affect the regional house prices (HPI) and regional trading volume (VOL). In addition, there exist period effects that capture shocks common to all regions' house prices and trade volume during our sample period.

When HPI is a dependent variable, all coefficients of VOL variables are positive and are statistically significant at 1% level. This result implies that, ceteris paribus, a 1% increase in a trading volume raises the regional house prices by 0.14% in our sample of 15 regions in the long run, based on the fixed effect model with regional dummy. In general, this finding confirms the result of causality test in the previous section.

In all four models, the coefficients of CPI are positive and statistically significant at 1% level. This indicates that the regional house prices provide a power of hedgeability against actual inflation. As expected, the house prices are also strongly influenced by the economic variables such as GDP, interest rate and stock price.[23)]

In the ARDL model of ⟨Table 8⟩, by and large, the short-run effects on the change in house prices are consistent with the results from fixed and random effect models in ⟨Table 7⟩ when HPI is a dependent variable. Meanwhile, although the magnitude of long-run elasticity of trading volume (VOL) on the house prices (HPI) in the ARDL model is much smaller compared to the coefficients of VOL in the fixed and random effect models in ⟨Table 7⟩, the change in trading volume positively influences the change in the house prices in the long run.

On the other hand, when the dependent variable is trading volume (VOL) in four models in ⟨Table 7⟩, the variables have positive and significant effects on regional trading volumes in the

⟨Table 7⟩ Panel estimation

Dependent variable	Fixed effect model (One way)	Fixed effect model (Two way)	Random effect model (One way)	Random effect model (Two way)
[HPI]				
$Constant$	-3.722***	-2.276***	-2.385***	-2.298***
VOL	0.146***	0.117***	0.109***	0.115***
CPI	1.712***	1.316***	1.345***	1.322***
IP	0.041*	0.057*	0.082**	0.084**
IR	-0.008*	-0.001	-0.001	-0.001
$STOCK$	0.099***	0.073***	0.073***	0.073***
$adj-R^2$	0.853	0.779	0.687	0.667
$F-statistics$	451.2***	274.1***	648.0***	589.7***
$Hausman\ h-test$	-	-	0.001	0.002
[VOL]				
$Constant$	-80.53***	-80.09***	-80.55***	-80.09***
HPI	0.476***	0.616***	0.470***	0.625***
CPI	2.072***	2.050***	2.073***	2.067***
IP	2.013***	2.022	2.011***	2.012
IR	0.423***	0.422***	0.422***	0.413*
$STOCK$	0.297*	0.286*	0.283*	0.281*
$adj-R^2$	0.840	0.927	0.750	0.474
$F-statistics$	408.5***	970.5***	884.4***	30.38***
$Hausman\ h-test$	-	-	0.001	0.003

Notes: ***, **, and * denote significant at 1%, 5% and 10% level, respectively.

23) We do not provide the additional explanations on the relationship between house prices (or volume) and economic variables since primary purpose of the present paper is to investigates how the house sales prices and trading volume act each other in our panel system.

long run. In ARDL model of ⟨Table 8⟩, the long-run effect of house prices on the trading volume is also statistically significant and positive. Further, the magnitude of the long-run elasticity is much larger than that from HPI being the dependent variable, which is identical to the results from ⟨Table 7⟩.

⟨Table 8⟩ Panel ARDL estimation (six-variable model)

	Dependent Variables	
	HPI	*VOL*
Constant	0.114	0.877***
(*Short run effect*)		
$\Delta\ln VOL_{t-1}$	0.027***	--
$\Delta\ln VOL_{t-2}$	0.021***	0.160***
$\Delta\ln VOL_{t-3}$	-0.002	0.098***
$\Delta\ln VOL_{t-4}$	--	0.061***
$\Delta\ln HPI_{t-1}$	--	0.273***
$\Delta\ln HPI_{t-2}$	0.304***	--
$\Delta\ln HPI_{t-3}$	0.218***	0.132*
$\Delta\ln HPI_{t-4}$	0.037	--
$\Delta\ln HPI_{t-5}$	--	0.218***
$\Delta\ln CPI_{t-1}$	0.358***	-0.628
$\Delta\ln CPI_{t-2}$	-0.307*	--
$\Delta\ln CPI_{t-4}$	0.403**	--
$\Delta\ln IP_{t-1}$	-0.029**	0.129***
$\Delta\ln IP_{t-2}$	-0.024	--
$\Delta\ln IP_{t-3}$	0.033*	--
$\Delta\ln IP_{t-4}$	--	-0.099
ΔIR_{t-1}	-0.006***	--
ΔIR_{t-2}	0.003	0.008
ΔIR_{t-4}	-0.007***	0.009
$\Delta\ln STOCK_{t-1}$	0.094***	0.013
$\Delta\ln STOCK_{t-4}$	0.007	--
Long-run Elasticity	0.023*	0.480**
ECT	-0.001*	-0.001*
Durbin-Watson	2.056	1.431
$adj-R^2$	0.395	0.607
$F-statistics$	38.86***	52.59***

Note: ***, **, and * denote significant at 1%, 5% and 10% level, respectively.

The two error correction terms (ECT) in the panel ARDL models in ⟨Table 8⟩ are negative and statistically significant at the 10% level, indicating another evidence of establishing the cointegration relations among the variables. The ECT measures the speed at which the house prices (or trading volume) adjust to the changes in explanatory variables before converging to their long-run equilibrium levels.

In sum, both the house prices and trading volume are affected by the economic variables, which confirms the results of cointegration and causality tests in the previous section.

In ⟨Table 8⟩, lagged house prices (lagged trading volume) have an impact on the trading volume (house prices) in the short run. This result confirms the empirical finding in ⟨Table 6⟩ that there exists a bi-directional causality between house prices and trading volume in the short run. In addition, lagged prices (lagged volume) positively affect the current values of house prices (trading volume), implying that there exists inertia rather than periodic reversion in the movement of regional house prices (trading volume). For example, if there is a housing bubble or if a bubble bursts, this market condition would last for some time.

Meanwhile, ⟨Table 9⟩ shows the result of panel ARDL estimation based on two-variable equations. Overall, the results are very similar to those of ⟨Table 7⟩ and ⟨Table 8⟩ in which other macroeconomic variables are included in the models. Evidence of positive relationship between house prices and trading volume is found in the short run and in the long run. Moreover, the effect of house prices on the trading volume is larger than that of trading volume on house prices, which is identical to the case of six-variable models.

〈Table 9〉 Panel ARDL estimation (two-variable model)

	Dependent Variables	
	HPI	*VOL*
Constant	0.001***	0.008***
$\Delta \ln VOL_{t-1}$	0.195**	0.228***
$\Delta \ln VOL_{t-2}$	0.003	0.133***
$\Delta \ln VOL_{t-3}$	-0.025***	0.090***
$\Delta \ln VOL_{t-4}$	-0.008	0.038
$\Delta \ln VOL_{t-5}$	0.014*	0.200***
$\Delta \ln VOL_{t-6}$	0.001	-0.046***
$\Delta \ln HPI_{t-1}$	0.390***	0.272***
$\Delta \ln HPI_{t-2}$	0.169***	0.145**
$\Delta \ln HPI_{t-3}$	0.007	0.060
$\Delta \ln HPI_{t-4}$	-0.012	-0.151*
$\Delta \ln HPI_{t-5}$	0.057**	-0.109
$\Delta \ln HPI_{t-6}$	-0.000	0.055
Long-run Elasticity	0.019*	0.405**
ECT	-0.002**	-0.001*
Durbin-Watson	2.005	1.500
$adj-R^2$	0.274	0.579
$F-statistics$	39.31***	143.0***

Note: ***, **, and * denote significant at 1%, 5% and 10% level, respectively.

In sum, our empirical finding confirms the importance of economic variables in the determination of prices and trading volume. Specially, regarding the feedback relationship between house prices and trading volume, the positive effect of house prices on trading volume is larger than that of the trading volume on the house prices in the short run as well as in the long run. This comovement of prices and volume is supportive of the theories in Stein (1995)[24] or Genesove and Mayer (2001)[25], which suggests that equity constraints or loss aversion, respectively. If this is the case, is our empirical finding in favor of the view of equity constraints, or is it supportive by the theory of loss aversion?

Although we need a further research regarding the positive relationship between house prices and trading volume, we conjecture this as follows. Considering the Korean housing market and macroeconomic situations during our sample period,[26] our finding appears to be supportive of the view of loss aversion. That is, the government policies such as maintenance of low interest rate and deregulation on the mortgage seem to make the participants in housing market be much more free from equity constraints than any other periods. On the contrary, faced with the contractionary situation in domestic housing markets due to the aftermath of global economic recession

24) Stein, J. C., 1995, ibid

25) Genesove, D. and C. J. Mayer, 2001, ibid.

26) In fact, the rate of change in trading volume in most regions does not show an upward trend during the most of our sample period, whereas the movement of house prices has an upward trend during specific periods in some regions. In contrast, the trading volume in regions such as Seoul, Gyeonggi and Incheon moves steadily with a low rate of change during most of the sample period. Moreover, the three regions show a downward trend in house sales prices after 2009 through 014. The movements of prices and trading volume, however, show an upturn after September in 2014. See note 27) below regarding this issue.

since 2006, the participants in real estate markets appear to anticipate a continuous fall or steadiness in house prices. Accordingly, a decrease in the expected future value of housing assets leads to a falling prices and thus to a lock-in of trading volume. Based on this explanation, our empirical results seem to be in favor of the view of lose aversion.[27)]

Ⅳ. Conclusions

Using a panel data set consisting of 15 housing markets in Korea, the primary purpose of this paper is to verify and estimate the relationship between the house sales prices and trading volume during 2006～2015. Overall, the results point several conclusions as follows.

First, the series are not stationary but are I(1) process, based on the CIPS test that allows for error CD in the panel. Second, the panel cointegration tests produce a stable long-run relationship among the variables in two-variable model as well as six-variable model. Third, the panel causality test with error correction term indicates that there exist short-run and long-run bidirectional causal relationships between house prices and trading volume. The causality tests also provide identical evidence when the exogenous variables are included in the model.

Fourth, using both the fixed effect and random effect model and ARDL model, the results of long-run estimates confirm the causality results in the sense that house prices positively and significantly influence on trading volume and vice versa. Therefore, it is evident that the feedback effect is found within our panel system. Specially, the positive effect of house prices on trading volume is larger than that of the trading volume on the house prices in the short run as well as in the long run.

In this context, the positive correlation between the two variables can be explained by the theory of loss aversion, considering the features of Korean housing markets and macroeconomic situations during the sample period. That is, a decrease or steadiness in expected future housing values appears to cause a decrease in prices and thus a fall in trading volume, faced with the downturn in domestic housing market.

Our empirical evidence of positive price-volume correlation suggests that Korean housing markets would not be efficient and/or be decentralized, based on the viewpoint of efficient market and rational expectation theory. In this case,

27) The demand for housing has sharply increased since September in 2014 due to deregulation on the mortgage markets (i.e., deregulation on LTV and DTI) and due to a sharp rise in rent prices. This leads to an increase in trading volume and thus to a rise in house prices. However, this phenomenon could not be applicable to the whole sample period but only to 7 months out of whole sample period (111 months). In this sense, our finding of casual relationship from trading volume to house prices should be interpreted with caution, and, therefore, is not necessarily based on the above mentioned explanation (i.e., the changes in trading volume and prices caused by the government policy).

our empirical finding could be a theoretical foundation for the government intervention in the housing markets to set up a policy for stabilizing the demand and supply as well as prices. Additionally, our finding that the exogenous variables affect the movement of both prices and volume across housing markets would provide important information for policy maker such that housing policies should be made along with the condition of macroeconomic sectors as well as the condition of housing sector itself.[28)]

Although the current study finds obvious evidence of positive price-volume correlation in housing markets, it has some limitations. For instance, the current study does not provide explicitly an economic mechanism to fully understand the comovement of house price-volume. Further investigation with specific microeconomic data related to prices and volume, therefore, should be required. We leave the exploration of this possibility for future research.

References

Berkovec, J. A. and J. L. Goodman, "Turnover as a measure of demand for existing homes", *Real Estate Economics,* 1996, Vol.24,.

Chan, S., "Spatial lock-in: Do falling house prices constrain residential mobility?", *Journal of Urban Economics,* 2001, Vol.49.

Chung, J. H. and H. S. Yoo, "The dynamic relationship between apartment price index and private consumption", *Korea Real Estate Academy Review,* 2014, Vol.59.

Engelhardt, G. V., "Nominal loss aversion, housing equity constraints, and household mobility: evidence from the United States", *Journal of Uran Economics,* 2003, Vol.53.

Genesove, D. and C. J. Mayer, "Nominal loss aversion and seller behavior: Evidence from the housing market", *Quarterly Journal of Economics,* 2001, Vol.116.

Jung, E. J. and K. W. Yi, "A study on the estimation of minimum volume to maintain liquidity in housing market", *Korea Real Estate Academy Review,* 2014, Vol.56.

Kao, C., "Spurious regression and residual-based tests for cointegration in panel data." *Journal of Econometrics,* 1999, Vol.90.

Kim, D. W. and J. S. Yu, "How selling-buying time preference affects on forming the relationship between housing price and trading volume", *Korea Real Estate Academy Review*, 2013, Vol.54,.

Lee, J. S. and C. H. Lee, "Analysis on the determinants of Korean housing price index in unstable housing market by volatility of the housing price", *Korea Real Estate Academy Review*, 2014, Vol.59,.

Lim, D. B. "The research on housing transaction volume and housing prices- with focus on local

28) The government announced a housing market policy such as deregulation on LTV and DTI (i.e., 9.1 housing policy on September 1 in 2014). In addition, the monetary authority has lowered interest rate, and currently maintains the record-low interest rate. As a matter of fact, under the change in housing market condition coupling with these government policies, the trading volume and house prices have soared.

taxes(acquisition tax)", *Korea Real Estate Academy Review*, 2014, Vol.55.

Lucas, R., "Asset prices in an exchange economy", *Econometrica,* 1978, Vol.46,.

Pedroni, P. "Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis." *Econometric Theory,* 2004, Vol.20.

Pesaran, M. H., "General Diagnostic Tests for Cross Section Dependence in Panels." Cambridge Working Papers in Economics No.435: University of Cambridge CESifo Working Paper Series No.1229, 2004.

Pesaran, M. H., "A pair-wise approach to testing for output and growth convergence", *Journal of Econometrics,* 2007, Vol.138.

Phillips, P. C. B. and D. Sul., "Dynamic panel estimation and homogeneity testing under cross section dependence", *Econometrics Journal,* 2003, Vol.6.

Stein, J. C., "Prices and trading volume in the housing markets: A model with down-payment effects", *Korea Quarterly Journal of Economics,* 1995, Vol.110.