ISSN 2409-2665
Journal of Logistics, Informatics and Service Science
Vol. 7 (2020) No. 2, pp. 14-24
DOI:10.33168/JLISS.2020.0202

A Study on the Information Spillover Effects Between Housing and Financial Markets

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Abstract. This study is undertaken to spot the main barriers on affordability of middle-income group in multi-ownership housing in Sonadanga residential district. To conduct this study secondary data are used from existing literature during this field. This study analyzed the price spillover effects and volatility spillover effects that may occur between the housing market and the financial market, with the EGARCH (1,1)-AR (1) model using housing price index and certification of deposit (CD) interest rate data. Based on the analysis, the price and volatility spillover effects and asymmetric volatility from the financial market to the Seoul apartment market existed. As for the asymmetric volatility of the housing market (financial market) in relation to the good news and bad news in the financial market (housing market), a large positive number was revealed in terms of asymmetric coefficient from the financial market to the housing market. This means that the housing market more sensitively responds to good news than to bad news with the same size. This study has significance in that it empirically examined whether CD rate can be used as a policy means for housing market stabilization.

Keywords: Housing Price, CD interest rate, EGARCH model, Spillover effect, Volatility.

1. Introduction

Through quantitative easing due to the coronavirus pandemic spreading nationwide, many people think that rich liquidity led to the housing price hike that has started in Seoul recently. The yardstick for selecting whether to possess overflowing liquidity with financial assets such as stocks or bonds or whether to own real estate assets such as housing is determined by market interest rate; that is, if the market interest rate is high, people will prefer financial assets with high liquidity turnover instead of real estate assets posing a high risk. However, the current market interest rate maintains a negative rate, while capital is concentrated on the housing market with a high expected rate of return. Here, interest rate becomes the opportunity cost in terms of financial assets or housing investment. Cho (2005) reported that Korean housing price volatility is closely related to interest rate. This study started from the need for an empirical test of price volatility spillover effects from CD's return of rate to the housing market. It also has a policy implication of housing market stabilization; namely, the volatility effects of rate of return on housing price volatility CDs can be examined with a metric model and, through this, the rate of return on CDs' indicators can be used as a means to implement housing market stabilization.

As a framework to analyze the relationship between the housing and financial markets, this study adopted spillover effects used frequently in the financial time series analysis. Although existing studies focused on economic factor analysis affecting the housing market, this study assumed differentiation by empirically examining price change and volatility spillover effects between the housing and financial markets using the EGARCH model. When looking into the studies on spillover effects in the stock market, they appear to be divided into price change spillover effects and volatility spillover effects. Volatility in financial economy indicates risk and is measured as variance in statistics. Although there are not many studies that adopted the spillover effect concept in the real estate market, studies such as those from Dolde and Tirtiroglu (1997), Guirguis, Giannikos, and Anderson (2005), Miller and Peng (2006), Kim(2009), Willcocks (2010), and Chang(2014) exist. Dolde and Tirtiroglu (1997) empirically analyzed real estate prices' spatial diffusion in the Connecticut and San Francisco real estate markets using the GARCH-M model. They insisted that time variable volatility existed in the two markets, whereas conditional variance and rate of return on real estate had a positive relationship. Guirguis, Giannikos, and Anderson (2005) criticized a problem that assumed coefficient fixation as a method to predict housing prices, showing prediction capability improvement using the Generalized Autoregressive Conditional Heteroskedastic (GARCH) model and considering coefficient's time variability and the Kalman Filter with an autoregressive presentation, compared with previous studies. Miller and Peng (2006) presented a result in which single housing value volatility is affected by increased housing value rate and increased rate of regional gross domestic product per capita. As a result of an analysis of mutual spillover effects on the price volatility of risk assets including stocks, bonds, and real estate using the GJR-M model, Kim (2009) reported that Korean stock market affects the volatility of the bond and real estate markets the most, though the volatility of the bond and real estate markets minimally affects the stock market's volatility. However, the volatility of the stock market and bond market has shown mutual spillover effects since the 1997 foreign exchange crisis; thus, Kim presented the weakening independence of the stock market. Willcocks (2010) analyzed housing price volatility by region, covering 13 regions in the UK using the GARCH and EGARCH models. He presented a study result where an ARCH effect existed in seven regions and an asymmetric effect existed in six regions. Jang (2014) analyzed the spillover effects of housing prices between regions using the concepts of generalization prediction error variance decomposition and spillover effect index. According to the analysis result, total spillover of housing price between regions was 53.5%, and so he found that spillover effects between regions existed quite commonly. He also stated that the spillover effect decreases as time elapses and that the spillover effect is in reverse relationship with the housing price index.

2. Methods

2.1. EGARCH Model

The EGARCH model is suitable for the analysis of an asymmetric effect that eased an assumption in which parameters should be all positive numbers to create a variance larger than 0 under the parameter assumption of the GARCH model. The conditional variance equation of the EGARCH model can be indicated as follows:

$$\sigma_t^2 = \exp\left[\omega_0 + \beta log(\sigma_{t-1}^2) + \alpha\left\{\left|\frac{\epsilon_{t-1}}{\sigma_{t-1}}\right| - \sqrt{\frac{2}{\pi}}\right\} + \theta\frac{\epsilon_{t-1}}{\sigma_{t-1}}\right] \quad (1)$$

The EGARCH model eased parameter restrictions. The estimated conditional variance equation becomes stable if $|\beta| < 1$ in the conditional variance equation as in Equation (1). The parameter measuring the asymmetric effect is θ. If $\frac{\epsilon_{t-1}}{\sigma_{t-1}} < 0$ and $\alpha - \theta$, and if $\frac{\epsilon_{t-1}}{\sigma_{t-1}} > 0$ and $\alpha + \theta$, volatility in the EGARCH (1,1) model responds asymmetrically. If the housing market's volatility responds to the price increase news shock more prominently, the θ value becomes positive (+); if the volatility more prominently responds to price decrease news shock, namely a leverage effect exists, the θ value becomes negative (-). This refers to an asymmetric information effect showing a more significant response to volatility by the market participants on the negative shock, compared to the positive shock with the same size. If $\theta \neq 0$, the shock becomes asymmetric. This study adopted a revised conditional variance equation presented in Eviews 7.0 in place of Equation (1) used by Nelson (1991). Equation (3) shows the EGARCH (1,1) model.

$$r_t = \mathrm{a} + \mathrm{b}r_{t-1} + \epsilon_t \quad (2)$$

$$\sigma_t^2 = \exp\left[\omega + \beta\log(\sigma_{t-1}^2) + \alpha\left|\frac{\epsilon_{t-1}}{\sigma_{t-1}}\right| + \theta\frac{\epsilon_{t-1}}{\sigma_{t-1}}\right] \quad (3)$$

However,

$$\omega = \omega_0 - \alpha\sqrt{\frac{2}{\pi}}$$

2.2. EGARCH Model for Two-Way Analysis of Price and Volatility

The estimated equations for two-way test of the bivariant EGARCH model are composed as shown in Equations (4) to (7). Upon an analysis of spillover effects from the financial market to the housing market, there are no price and volatility spillover effects assumed from the housing market to the financial market. Reversely, there are price and volatility spillover effects from the financial market to the housing market upon an analysis of spillover effects form the housing market to the financial market.

$$r_{1,t} = \beta_{1,1} + \beta_{1,2} r_{1,t-1} + v_{1,t} \tag{4}$$

$$r_{2,t} = \beta_{2,1} + \beta_{2,2} r_{1,t-1} + \beta_{2,3} r_{2,t-1} + v_{2,t} \tag{5}$$

$$\sigma_{1,t}^2 = \exp\left[\alpha_{1,1} + \alpha_{1,2}\left|\frac{v_{1,t-1}}{\sigma_{1,t-1}}\right| + \alpha_{1,3}\frac{v_{1,t-1}}{\sigma_{1,t-1}} + \gamma_1 log\sigma_{1,t-1}^2\right] \tag{6}$$

$$\sigma_{2,t}^2 = \exp\left[\alpha_{2,1} + \alpha_{2,2}\left|\frac{v_{2,t-1}}{\sigma_{2,t-1}}\right| + \alpha_{2,3}\frac{v_{2,t-1}}{\sigma_{2,t-1}} + \gamma_2 log\sigma_{2,t-1}^2 + \gamma_1 log\sigma_{1,t-1}^2\right] \tag{7}$$

Here, the suffix of each variable and coefficient has classified each market. In the case of the spillover effect from the financial market to the housing market, 1 indicates financial market, and 2 indicates housing market. Inversely, in the case of spillover effect from the housing market to the financial market, 1 indicates housing market, and 2 indicates financial market. For price spillover from the financial market to the housing market, one may estimate by adding the previous period variable r_(1,t-1) in the financial market's rate of return on CDs to the housing market's average equation, and by adding the conditional variance log value logσ_(1,t-1)^2 of rate of return on CDs in the financial market to the conditional variance equation. Through the bivariant EGARCH model, one may estimate not only the price spillover effects generated within each market, but the asymmetric spillover effects of volatility generated from the financial market (housing market) to the housing market (financial market).

3. Results

3.1. Data and Stability Test

The data used in this study were monthly nationwide housing index and Seoul apartment price index announced by the Kookmin Bank and CD data released by the Bank of Korea. The monthly rate of return of the housing price index is defined as the natural log of the ratio of the previous month's index to the current month's index. In $R_t = l_n(P_t/P_{t-1})$, P_t is the housing price index of t day. The use period of the data was from January to July 2020, and the monthly data were used after seasonal adjustment. Meanwhile, the time series analysis is based on stationary. Therefore, in order to verify the stationary of variable, ADF (Augmented Dicky-Fuller) and PP (Phillips Perron) unit root test were carried out. Table 1 shows the result and basic statistics.

Table. 1: Basic Statistics of Housing Price and CD Interest Rate

	Housing Price Nationwide		**Seoul Apartment Price**		**CD Interest Rate**	
Mean	0.2797		0.4264		-0.0081	
Std. Dev.	0.4472		0.9169		0.0501	
Skewness	2.5362		2.4746		-2.7178	
Kurtosis	13.0549		11.8313		18.4851	
Jarque-Bera	1173.19		948.01		2491.33	
Probability	(0.0000)		(0.0000)		(0.0000)	
	Level variable	Differential variable	Level variable	Differential variable	Level variable	Differential variable
ADF	-0.9792	-7.1514***	-0.0838	-7.1149***	-1.3183	-8.1735***
PP	-1.7973	-6.0210***	-0.8247	-6.1957***	-1.1176	-7.5791***

Note: 1. ( ) is the significance level that can reject the null hypothesis.

2. p<0.01***, P<0.05**, P<0.1*

3. The lag for the test was selected as 1, and the constant term was included.

In Table 1, the housing prices, except for CD rate, were distributed in the positive (+) direction in a biased way and in terms of skewness, with kurtosis having a sharper spinode than normal distribution. In terms of Jarque-Bera statistics, the null hypothesis that housing price and CD volatility distribution is normal distribution was rejected at 1% significance level; thus, setting GARCH model based on heteroscedasticity is necessary. As a result of performing the ADF and PP tests to ascertain the status of time series variables being stationary, all the time series data were stationary at 1% significance level.

Meanwhile, Table 2 shows the Ljung-Box Q statistics test result at time lags 6 and 12 on volatility and square of volatility in order to test whether the GARCH type of model can be applied. The Ljung-Box test statistics expressed with Q statistics has chi-square distribution under the null hypothesis that rate of return and square of rate of return comply with a strong white noise process. As a result of the test, the Q statistics' p values on time lags 6 and 12 in terms of housing price, CD rate volatility, and the square of volatility were all 0, rejecting the null hypothesis. This means that autocorrelation exists, which implies the existence of heteroscedasticity according to Bollerslev (1986) and Hsieh (1989). In other words, a substantial (or slight) change is implied if a huge (or small) change appears in the housing price and CD rate volatility. Therefore, the OLS estimation that assumes that the variance of residual is constant is not appropriate, and the ARCH models can be applied.

Table 2 shows the asymmetric test of Engle and Ng (1993). The asymmetry of volatility is reviewed by dividing tests into sign bias test (SB), negative size bias test (NSB), positive size bias test (PSB), and joint test. The original regression equation is $y_t = \beta' Z_t + \varepsilon_t$. Here, S_{t-1}^{-} is $e_{t-1} < 0$, 1, or if not, 0, which refers to a dummy, and $S_{t-1}^{+} = 1 - S_{t-1}^{-}$.

$$SB: u_t^2 = \mathrm{a} + \mathrm{b}S_{t-1}^{-} + \beta' Z_t^* + e_t,\ H_0 : b = \beta = 0 \tag{8}$$

$$NSB: u_t^2 = \mathrm{a} + \mathrm{b}S_{t-1}^{-} e_{t-1} + \beta' Z_t^* + e_t,\quad H_0 : b = \beta = 0 \tag{9}$$

$$PSB: u_t^2 = \mathrm{a} + \mathrm{b}S_{t-1}^{+} e_{t-1} + \beta' Z_t^* + e_t,\quad H_0 : b = \beta = 0 \tag{10}$$

$$JOINT: u_t^2 = \mathrm{a} + b_1 S_{t-1}^{-} + b_2 S_{t-1}^{-} e_{t-1} + b_3 S_{t-1}^{+} e_{t-1} + \beta' Z_t^* + e_t$$
$$H_o = b_1 = b_2 = b_3 = \beta = 0 \tag{11}$$

The asymmetric test result in Table 2 shows that housing has asymmetry in PSB and Joint, while the CD interest rate has asymmetry in NSB and Joint at 10% significance level, respectively. Therefore, ARCH effect exists in CD rate, and so the EGARCH model should be applied.

Table. 2: Autocorrelation and Asymmetric Test Statistics

	Autocorrelation				**Asymmetry**			
	Q(6)	**Q(12)**	**Q2(6)**	**Q2(12)**	**SB(t)**	**NSB(t)**	**PSB(t)**	**JOINT(F)**
Housing nationwide	200.42 (0.000)	211.18 (0.000)	77.72 (0.000)	85.54 (0.000)	0.3876	-1.2934	6.1486*	14.3519*
Apartments in Seoul	142.42 (0.000)	165.85 (0.000)	57.76 (0.000)	65.86 (0.000)	-0.0561	-0.9356	5.6223*	12.6918*
C D Interest rate	85.78 (0.000)	92.30 (0.000)	30.04 (0.000)	30.30 (0.000)	0.2291	-4.7678*	1.1313	8.7515*

Note: 1) Q (6) and Q (12) refer to volatility, and the Q2(6) and Q2(12) refer to the Ljung-Box statistics of the square of the volatility at time lags 6 and 12.

2) ( ): indicates p-value. *: figurative at 10% significance level

3.2. Analysis Results

3.2.1. Analysis of Spillover Effects from the Financial Market to the Housing Market

Table 3: Analysis of Spillover Effects from the Financial Market to the Housing Market

	Financial Market->Nationwide Housing Market		Financial Market->Seoul Apartment Market	
	Coefficient value	z-statistics	Coefficient value	z-statistics
$\beta_{2,1}$	0.2711	2.8220***	0.2963	1.8868**
$\beta_{2,2}$	-0.1460	-0.7310	-1.3253	-3.6128***
$\beta_{2,3}$	0.8763	22.6910***	0.8646	23.2433***
$\alpha_{2,1}$	-0.2287	-4.9705***	-0.3951	-7.9567***
$\alpha_{2,2}$	0.0896	1.5799	0.3872	6.0713***
$\alpha_{2,3}$	0.3214	7.0175***	0.2969	7.1450***
γ_2	0.9568	88.3182***	0.9498	59.8926***
γ_1	0.0079	1.6284*	0.0107	1.6379*
R^2	0.5309		0.4250	
DW	1.8247		1.9096	
log L	64.95		-103.95	

Note: ***, **, *: Each is significant at 1%, 5%, and 10% significance level, respectively.

Table 3 shows the spillover effect analysis results from the financial market to the housing market. When the CD rate spillover effects from the financial market to the housing market were considered, β_2,2 was not significant in the nationwide housing market, but it was significant at 1% significance level in the Seoul apartment market. Thus, interest rate spillover effects were revealed from the financial market to the Seoul apartment market. This means that a 1% increase of CD rate causes 1.3% decline of Seoul apartment price. In the case of γ_1 explaining the volatility spillover effect, it was significant at 10% significance level in the nationwide housing and Seoul apartment markets. The coefficient values were 0.0079 in the nationwide housing market and 0.0107 in the Seoul apartment market, which means smaller values were revealed than γ_2 value. This explains the impact of the previous month's volatility: 0.9568 and 0.9498. To evaluate this from a long-term perspective, the volatility of nationwide housing and Seoul apartment markets are sharply affected by the previous month's volatility, although the volatility effect from the financial market is small. For α_2,3 explaining an asymmetric volatility spillover effect according to incoming information, the nationwide and Seoul apartment markets were noteworthy at 1% significance level, which means that the asymmetric volatility spillover effects are revealed from the financial market to the housing market as asymmetric effect exists due to news (information) shock. Therefore, the volatility spillover effect and asymmetric volatility exist although the price spillover effect from the financial market to the nationwide housing market does not, whereas the price and volatility spillover effects and asymmetric volatility exist from the financial market to the Seoul apartment market.

3.2.2. Analysis of Spillover Effects from the Housing Market to the Financial Market

Table 4: Analysis of Spillover Effects from the Housing Market to the Financial Market

	Nationwide Housing Market->Financial Market		Seoul Apartment Market->Financial Market	
	Coefficient value	z-statistics	Coefficient value	z-statistics
$\beta_{2,1}$	-0.0063	-2.2265**	-0.0075	-3.5781***
$\beta_{2,2}$	0.0137	1.8855**	0.0073	3.0459***
$\beta_{2,3}$	0.1662	3.4378***	0.4256	8.0042***
$\alpha_{2,1}$	-8.2707	-23.4460***	-11.7593	-50.1467***
$\alpha_{2,2}$	1.0926	8.9973***	0.6688	9.3085***
$\alpha_{2,3}$	-0.0758	-0.9856	-0.2082	-4.0677***
γ_2	-0.1226	-1.9638**	-0.6682	-19.0783***
γ_1	0.0044	2.2663**	0.0099	1.1758
R^2	0.1788		0.0099	
DW	1.2278		1.7654	
log L	430.20		434.80	

Note: ***, **, *: Each is significant at 1%, 5%, and 10% significance level, respectively.

Table 4 shows an analysis results of the spillover effects from the housing market to the financial market. When the housing price spillover effects from the nationwide housing and Seoul apartment market to the financial market were assessed, $\beta_{2,2}$ was significant at 1%-5% significance level in the financial market, so positive (+) price spillover effects are shown from the housing market to the financial market. The 1% rise of nationwide housing price increased by 0.0137% of the CD rate, and the 1% rise of Seoul apartment price increased by 0.0073% of the CD rate but the increases were minimal. For γ_1 explaining a volatility spillover effect, the effect was significant at 5% significance level from the nationwide housing market to the financial market, but the effect was not significant from the Seoul apartment market to the financial market. The coefficient values were 0.0044 and 0.0099 in the financial market, respectively, which were larger than the γ_2 values −0.1226 and -0.6682, explaining previous volatility effects. When evaluating from a long-term perspective, the financial market volatility was less affected by the previous month's vitality, but the volatility effects from the housing market were larger. For $\alpha_{2,3}$ explaining asymmetric volatility spillover effects according to the incoming information, the effects were not significant from the nationwide housing market to the financial market, but they were significant at 1% significance level in the Seoul apartment market. This means that asymmetric volatility spillover effects are shown from the Seoul apartment market to the financial market; that is, a leverage effect exists by new (information) shock. Therefore, although the price and volatility spillover effects exist from the nationwide housing market to the financial market, the asymmetric volatility does not exist. Although the price spillover effects and asymmetric volatility exist from the Seoul apartment market to the financial market, the volatility spillover effects do not.

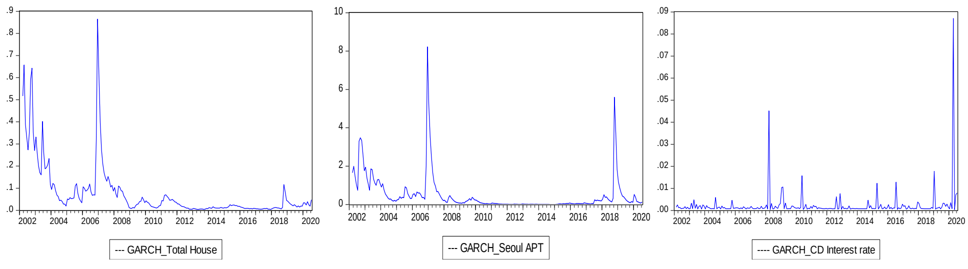

Fig. 1: Estimated Volatility Result.

Figure 1 shows the conditional variance drawn from the nationwide housing market, Seoul apartment market, and financial market. Although the nationwide housing and Seoul apartment price volatilities were high from the early 2000s until the 2008 global financial crisis, the Seoul apartment price volatility has become rapidly high since 2018. The fact that the Seoul apartment price volatility was much higher than the nationwide housing price volatility represents the Seoul apartment price trend, and can be viewed as Seoul apartment prices' relatively higher increase than that of the nationwide housing price.

4. Discussions and Conclusion

This study analyzed the price spillover and volatility spillover effects that may occur between the housing and financial markets using the EGARCH (1,1)-AR (1) model. As a result of testing with Ljung-Box Q statistics on whether the GARCH type model can be applied with a model to analyze housing price and CD rate volatility time series data, heteroskedasticity existed; hence, the application of the GARCH model is valid. According to the asymmetric test result, the EGARCH model can be applied as the ARCH effects existed in housing price and CD rate.

To summarize the empirical analysis result, the price spillover effects did not exist from the financial market to the nationwide housing market; however, volatility spillover effects and asymmetric volatility did. In the financial market, the price and volatility spillover effects and asymmetric volatility were all present from the financial market to the Seoul apartment market. The price and volatility spillover effects transpired from the nationwide housing market to the financial market, but asymmetric volatility did not occur. The price spillover effects and asymmetric vitality existed from the Seoul apartment market to the financial market, whereas volatility spillover effects did not take place. As for the asymmetric volatility in the housing market (financial market) in relation to good news and bad news in the financial market (housing market), the coefficient $\alpha_{2,3}$ was the larger positive number from the financial market to the housing market compared from the housing market to the financial market. This means that the housing market more sensitively responds to good news than bad news with the same size. This study has significance in that the price and volatility spillover effects between CD rate and housing market were empirically examined and in that policy implications exist since CD rate can be used as a policy instrument for housing market stabilization.

This research is limited to the relationship between CD rate, out of various interest rates in the financial market, and housing market, and so falls short of generalization. To examine the information spillover effects more carefully between the financial and housing markets, the use of comparative studies between domestic and international markets and a variety of financial market data is required, and thus a further study is needed.

Acknowledgement

The funding for this paper was provided by Namseoul University, South Korea.

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