The Nonlinear Interaction of Real Estates and Economic Growth in China

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Abstract: ***This paper provides a model for verifying the effects of real estate, because real estate industry has a fairly important position in the Chinese economy. This paper uses the nonlinear optimized techniques to estimate EGARCH(1,1)-GED model. Due to autocorrelation, kurtosis and volatility clustering, this paper adopt the EGARCH(1,1)-GED model. This paper uses monthly data of gross domestic products, housing prices, interest rates, exchange rates, consumer prices and stock price index, and the analysis period is 18 years from January 2000 to December 2017, The empirical findings are as follows. First, the rise in housing prices increases both the return and volatility of GDP growth of China. The empirical findings that changes in housing prices have a greater impact on GDP growth of China than changes in interest rates are consistent to prior studies. Second, we found that changes in new housing prices have a relatively greater impact on economic growth than changes in existing housing prices. This empirical result is a new one that has not been found in previous studies. Third, changes in real interest rates have a relatively greater impact on GDP growth in China than changes in normal interest rates. Fourth, in contrast to the significant impact of Beijing's housing prices on economic growth, the housing prices in Hong Kong has shown insignificant impact on GDP growth in China. According to these findings, real estate development has an effect in the GDP growth of China. In light of the empirical results, China's policy authorities should monitor the price trends of the new housing prices and make efficient management accordingly.***

Keywords : EGARCH Model, Nonlinear Interaction, Real Estates, Volatility.

I. INTRODUCTION

A Markov chain is a stochastic random process which satisfies the property of discrete state space. Since ARCH-family and GARCH-family models are introduced, studies of applying these models have begun to appear. Many authors are studying the effects of real estate price changes on economic growth in advanced and emerging countries using these models. In recent years, as the rapid growth of real estate economy in China has the character of representing the Chinese economy, real estate market and the price of houses are important factors of macro economy[1]. China's real estate industry is one of key axes of the economy, and also one part of financial system. Housing sales in 2017 reached 13.37 trillion Chinese Yuan, which is large enough to be equal to about 15% of China's gross domestic product. The real estate market interacts with Chinese financial system through multiple routes. First, real estate is the largest asset of Chinese household's portfolio. This is partly because there are no other investment options. Second, local government in China relies on real estate sales for much of its fiscal income and uses real estate sales revenues as collateral for debt financing. Third, Chinese companies are also using real estates to raise debts. China's real estate market has been booming since the 1990s, and this boom has led to substantial concerns in both academic and policy circles[2].

To analyze the asymmetric effect of real estates changes on China's GDP growth, it is necessary to use appropriate model which is properly identify those characteristics. But most literature in analyzing the real estates changes effects on GDP growth in China are used the Granger causality test[3]. [4] examines the relationship between housing or non-housing investments and GDP growth of China using Granger causality analysis. They find that China's GDP growth is relatively more affected by housing investments than by non-housing investments in short-term. They also find that China's economic growth is greatly affected in short term by housing investments. [5] examines how changes in real estates affect the economy in China using panel Granger method, and find that investments in real estates has an effect on the economy in China. But they also find that effect of investment in real estates does not exist if per capita GDP is less than $1,000. [6] uses the dynamic model of panel data to analyze how the investments in real estates affects the economy in China, and find that the investments in real estates has a positive and significant effect on the economy of China, and these effects are identified at the national level as well as the regional level. [7] examines the influencing factors to economic in Sichuan province in China using Basso, and find that real estate growth rate on economic growth in Sichuan is not significant. [8] examines whether real estates market affects the private investments, and find that the growth of the real estates market has an important impact on the private investment's growth. [9] examines how real estates fluctuations affects China's economic fluctuations using OLS and Granger causality test, and find that real estate industry is the most powerful pull of China's economic growth momentum.

The nonlinear relationship between real estate price changes and economic growth in China is worth considering, but there are few of articles about this. This study analyzes the nonlinear influence mechanism of real estate effect on economic growth in China. This study evaluates the effect of real estate price changes in China again especially with regard to dynamic and nonlinear characteristics.

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Thus, this work aims to effectively examines the dynamic and nonlinear effects of real estate on GDP growth in China. The contribution of this study is to compare the effect of nominal interest rate with that of real interest rate to capture the effects of inflation. And this study is to compare the effect of the effect of house price in Beijing with the effect of house price in Hong Kong. The main purpose of this paper is to examine the nonlinear relationship between real estate price changes and economic growth in China using a volatility model.

II. MATERIALS AND MODELS

A. Data

This study analyzes whether the effect on the economy of real estates changes in China is asymmetrical using monthly data of gross domestic products, the new house prices or existing house prices in Beijing or Hong Kong, nominal or real interest rates, exchange rates, consumer price, and the Shanghai stock exchange index. The analysis data is obtained from OECD statistics. Sample period is 18 years from January 2000 to December 2017.

B. Methodology

This study uses EGARCH(1,1)-GED model, which is the nonlinear optimization techniques. Maximum likelihood estimates are based on Marquardt algorithm. Due to kurtosis, autocorrelation and volatility clustering, we adopt EGARCH model created by [10]. [11] has analyzed several volatility models and found that GARCH(1,1) is relatively superior to other sophisticated models. GARCH model does not explain asymmetric aspects, but EGARCH model can capture leverage effects.

Step 1: The GARCH model developed by [12] allows the conditional variance, and the basic structure of symmetric GARCH model allows its conditional variance to be affected by its previous lags. Estimate the GARCH(1,1) -M model using the formula

$$y_t = \alpha + \beta h_t + \varepsilon_t \tag{1}$$

$$h_t = \alpha_0 + \beta_1 h_{t-1} + \alpha_1 \varepsilon_{t-1}^2 \tag{2}$$

Here y_t is the monthly GDP growth in time t, h_t is the conditional variance and ε_t is conditionally normal distributed.

Step 2: Considering some limitation in GARCH(1,1) model, estimates the EGARCH(1,1) model using the formula:

$$r_{j,t} = \delta_j' I_{j,t-1} + \xi_{j,t} \tag{3}$$

$$\xi_{j,t} = \sigma_{j,t} + z_{j,t} \tag{4}$$

$$z_{j,t} : \Omega_{t-1} \sim \varphi(0,1,\upsilon) \tag{5}$$

$$\ln\sigma_{j,t}^2 = \omega_j + \beta_j \ln(\sigma_{j,t-1}^2) + \gamma\left(\frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}}\right) + \alpha\left[\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right] \tag{6}$$

Here $\sigma_{j,t}^2$ is the conditional variance in time t, $z_{j,t}$ is the standard residual and $\varphi(\cdot)$ denotes a function of conditional density. ν is a parameters vector.

Step 3: Formulating the GARCH(1,1)-GED model, giving out the distribution density for it[1]:

$$f(x:\varpi,\sigma,\gamma) = \frac{r\cdot\Gamma(\frac{3}{\gamma})^{1/2}}{2\sigma\cdot\Gamma(\frac{1}{\gamma})^{3/2}}\exp - + \frac{\Gamma(\frac{3}{\gamma})}{\Gamma(\frac{1}{\gamma})}\left(\frac{x-\mu}{\sigma}\right)^{2\gamma/2} \tag{7}$$

Here $\Gamma(\cdot)$ is GAMMA function, and $0 < \gamma \le \infty$. If variate x is extracted from this probability density function, we will depict $x \sim G(\mu,\sigma^2,\gamma)$. We estimate the GARCH-GED model below:

$$\varepsilon_t : I_{t-1} = \sqrt{h_t}\nu_t \tag{8}$$

$$\nu_t = G(0,1,\gamma) \tag{9}$$

$$h_t = \alpha_0 + \beta_1 h_{t-1} + \alpha_1 \varepsilon_{t-1}^2 \tag{10}$$

Then we have

$$y_t = c + \varepsilon_t \sim GED\ (c,h_t,\gamma) \tag{11}$$

Step 4: The EGARCH(1,1)-GED model for examine the nonlinear interaction of real estate prices and economic growth is as follows:

$$gdp_t = \alpha_0 + b_1 hp_t + b_2 ir_t + b_3 er_t + b_4 cpi_t + b_5 ssec_t + \varepsilon_t \tag{12}$$

$$\ln h_t = \alpha_1 + \beta\ln(\sigma_t^2) + \gamma\left|\frac{\varepsilon_{t-1}}{h_{t-1}}\right| + \delta\frac{\varepsilon_{t-1}}{h_{t-1}} + c_1\ln\varepsilon_{hp}^2 + c_2\ln\varepsilon_{ir}^2 + c_3\ln\varepsilon_{er}^2 + c_4\ln\varepsilon_{cpi}^2 + c_5\ln\varepsilon_{ssec}^2 \tag{13}$$

Here gdp_t is the growth of gross domestic product in China in time t, hp_t is the new house price or existing house price in time t, ir_t is the nominal interest rate(NIR) or real interest rate(RIR) in China in time t, er_t is the exchange rate in China in time t, cpi_t is the consumer price index in China in time t, $ssec_t$ is the Shanghai stock exchange index in time t, and ε_t is conditionally GED distributed.

III. RESULT AND DISCUSSION

Prior to empirical analysis, whether the sample series data is stationary is required to be tested. The PP test and the ADF test were used to perform unit root test.

The test results of first differenced variables reject the null hypothesis, so the log-differenced variables are used for analysis.

Table 1: Effects of existing house price on GDP

Equation	Parameter	Coefficient(P-value)	
		NIR	*RIR*
Mean	α0	-0.0062(0.0000)	-0.0077(0.0032)
	b1	0.1402(0.0131)	0.1253(0.0446)
	b2	-0.0625(0.0865)	-0.1159(0.0318)
	b3	0.0463(0.6952)	0.1056(0.4381)
	b4	-0.1023(0.4779)	0.1901(0.4394)
	b5	-0.0020(0.9021)	0.0018(0.9032)
Variance	α1	-9.0009(0.0001)	-8.4405(0.0000)
	β	-0.1788(0.4971)	0.1328(0.4196)
	γ	1.3127(0.0014)	1.0196(0.0062)
	δ	0.0381(0.8458)	0.1932(0.4473)
	c1	13.0685(0.0820)	47.9734(0.0380)
	c2	-1.2210(0.3903)	-9.7207(0.1941)
	c3	-7.6588(0.5889)	18.2311(0.6132)
	c4	-8.3175(0.6570)	71.4447(0.4161)
	c5	0.2918(0.3692)	10.00165(0.1163)
Log-Likelihood		279.2614	287.0744

Table 1 shows the effect of the existing house prices in Beijing on GDP growth in China. As shown in Table 1, the existing house prices in Beijing(b_1) and interest rates(b_2) have statistically significant effect on the economy of China, but other variables did not significantly affect economic growth of China. The rise of house prices is a factor that causes a decrease in the economy of China. But the rise of interest rates leads to a decrease of China's economic growth. Based on the coefficients' size, we can conclude that the economic growth in China is more sensitive to house price changes in comparison to the interest rate changes. We did not find the leverage effect in the variance equation based on the δ coefficient. And we found that the rise in the interest rate changes have significant effect on the economy of China. Namely, the increase in house price changes significantly increases the volatility of the economy of China. Therefore, it can be seen that the rise in house prices increases both the return and volatility of the economy of China

Table 2: Effects of new house price on GDP

Equation	Parameter	Coefficient(P-value)	
		NIR	*RIR*
Mean	α0	-0.0077(0.0000)	-0.0017(0.0000)
	b1	0.2751(0.0436)	0.5040(0.0000)
	b2	-0.1102(0.0035)	-0.1663(0.0004)
	b3	0.1006(0.2147)	0.1216(0.2402)
	b4	-0.2662(0.0739)	0.4407(0.0999)
	b5	-0.0136(0.4379)	0.0067(0.5659)
Variance	α1	-8.6404(0.0000)	-7.5543(0.0000)
	β	-0.1649(0.4586)	0.2774(0.0497)
	γ	0.9822(0.0024)	1.4503(0.0002)
	δ	-2.3692(0.1941)	-0.2050(0.4326)
	c1	24.4732(0.0923)	55.4912(0.0306)
	c2	-2.3940(0.1130)	-9.1845(0.1552)
	c3	-9.7948(0.1148)	-8.7790(0.6828)
	c4	-8.2715(0.1540)	82.5813(0.3885)
	c5	1.2070(0.6301)	11.0341(0.1096)
Log-Likelihood		272.2174	282.0078

Table 2 presents the effect of the new house prices in Beijing on the economy of China. Similar to the results in Table 1, the new house prices in Beijing and interest rates have significant effects on the economy of China. But unlike the results in Table 1, the consumer price index also has significant effects on the economy of China. The effect of consumer price on the economy of China is smaller than that of house price and interest rate on the economy of China based on the coefficients' size. Similar to the results in Table 1, the economic growth in China is more sensitive to house price changes in comparison to the interest rate changes. Based on Table 1 and Table 2, it would be that changes in new house prices have a relatively greater impact on economic growth in China than changes in existing house prices. Also changes in the real interest rates have a relatively greater impact on the economy of China than changes in nominal interest rates. We also did not find the leverage effect in the variance equation based on the δ coefficient in Table 2. And it is also shown that the increase in house price changes significantly increases the volatility of the economy of China.

Table 3: Effects of Hong Kong house price on GDP

Equation	Parameter	Coefficient(P-value)	
		NIR	*RIR*
Mean	α0	-0.0075(0.0000)	-0.0069(0.0000)
	b1	0.0397(0.5236)	0.0516(0.4548)
	b2	-0.2751(0.0000)	-0.3322(0.0000)
	b3	-0.0329(0.5924)	-0.0580(0.5553)
	b4	-0.3169(0.0758)	0.8523(0.0614)
	b5	-0.1196(0.3527)	0.1272(0.2835)
Variance	α1	-9.1007(0.0000)	-9.3350(0.0000)
	β	-0.0068(0.6257)	0.0989(0.5271)
	γ	1.5266(0.0000)	1.5771(0.0000)
	δ	0.0832(0.6581)	0.0701(0.7061)
	c1	-2.5637(0.5629)	-1.2557(0.7710)
	c2	-9.1964(0.0436)	-9.4487(0.0066)
	c3	-9.6637(0.1574)	-8.5192(0.2056)
	c4	-8.5264(0.1643)	41.9457(0.2684)
	c5	0.2568(0.6238)	-0.6776(0.8435)
Log-Likelihood		279.2614	277.7728

Table 3 provides the effect of the house prices in Hong Kong on the economy of China. In contrast to the house price in Beijing's significant impact on the economy of China, the house price in Hong Kong has shown insignificant impact on the economy of China. The consumer price index also has significant effects on the economy of China. Just like the previous empirical results, leverage effect does not exist in the variance equation based on the δ coefficient. And it is difficult to find empirical results that the increase in the interest rate changes has a significant effect on the economy of China. But we found that the increase in interest rate changes significantly increases the volatility of the economy of China.

IV. CONCLUSION

This paper analyzed the dynamic and asymmetric effect of the changes of real estates on the economy of China using EGARCH(1,1)-GED model. This paper used monthly data of gross domestic products, the new house prices or existing house prices in Beijing or Hong Kong, nominal or real interest rates, exchange rates, consumer price index, and the Shanghai stock exchange index. The analysis period is 18 years from January 2000 to December 2017.

The findings are as follows. First, the rise in house prices increases both the return and volatility of the economy of China. The rise of house prices leads to an increase of the economy of China, but the rise of interest rates leads to a decrease of the economy of China. And we found that the GDP growth in China is more sensitive to house price changes in comparison to the interest rate changes. Second, the consumer price index also has significant effects on the GDP growth in China, but the effect of consumer price on the economy of China is smaller than that of house price and interest rate on economic growth. Third, we found that changes in new house prices have a relatively greater impact on the GDP growth in China than changes in existing house prices. Fourth, we found that changes in real interest rates have a greater impact on economic growth in China than changes in nominal interest rates. Fifth, in contrast to the house price in Beijing's significant impact on the economy of China, the house price in Hong Kong has shown insignificant impact on the economy of China.

According to our findings, real estate development has an effect in the economy of China. The empirical findings of this paper reconfirmed the effects of dynamic and nonlinear relationship between real estates changes and the economy of China. In light of the empirical results that the new house prices have a relatively greater impacts on the economy of China than the existing house prices, China's policy authorities will have to monitor the price trends of new house prices and make efficient management accordingly. China's economic authorities should manage the real estate industry to promote the economy of China, and should ensure the right threshold that optimizes economic growth.

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