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The Comovement Effect of Macroeconomics and House Market in CH-HK-TW

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Abstract

As the late repayment of the 2007 US subprime mortgage has gradually became worse, real estate investors started with short-sale and detonated a mobile crisis. Using global VAR model , we founded that the changes of U.S. GDP growth rates are helpful to predict the volatility of GDP growth rates of China, Hong Kong and Taiwan. The changes of China stock indexes could significantly predict the changes of Hong Kong stock indexes. And, all regional stock price indexes have significant effects to house price indexes. The interest rates of Taiwan and China are helpful to predict the interest rate of Hong Kong. The impacts of the changes of interest rates to the house price indexes showed a negative signal for each area. For the housing market index, the housing price index of Hong Kong could be used to predict the house price fluctuations of the United States and China. There is a significantly mutual predictable function among Hong Kong, Taiwan and China for the volatility effects of house price indexes.

JEL classification numbers: E32, E50, R21
Keyword: Global VAR(GVAR), Vector error correction model, Impulse responses, House market index, Comovement

1 Introduction

The financial crisis emerged from domestic markets in 2008, through the path of international transmission, triggered global financial crisis and put global economic activity into a serious recession. Real estate is the quintessential non-tradable asset, and it is a typical asset with sectional boundary liquidity. But, the collapses of prices of offices of U.S. in early 1990s, and prices of houses in 2008, and the crisis of subprime mortgage in 2008 caused U.S. stock market slumped and put global financial market serious

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recession. Whether the real estate is the same as other assets possess an asset liquidity? Morris and Heathcote (2004) pointed out that for the general public the housing is the main asset, and the big price volatility in asset markets, not only impacts the macro-economy of a country also has a tremendous influence on financial stability. Case et al. (1999) pointed out that real estate prices, and local GDP component and international GDP component are significantly interrelated. The fluctuations of international house prices should be partially interpreted as facing the international economy circle collectively.

What is the relationships of real estate to security markets and to macro-economy? Okunev J., P. Wilson, Zurbruegg R. (2002) found that Australia's real estate market and the stock market influences with each other. Kakes and Willem (2004) found that the housing market of the Netherlands affects the stock price, and thus significantly affects the economy. Bonnie (1998), Parker (2000), Iacoviello (2005) studied that the interrelationships among house price, interest rate, stock price and macro-economy, and found that a stable economy was under the control of interest rate, and the housing market changes significantly affected the macro-economy. Beltratti and Morana (2010) thought that housing prices and macro-economy developments were in different directions. Otrok and Terrone (2005) studied that the linkage factors of international housing price and found that it the movement of global interest rates. Taylor (2007) pointed out that big fluctuations in interest rates will lead to house price fluctuations. And, Bernanke (2010) thought that the mobile interest rate, the interest-paying only mortgage increase continuously and underwriting standards continue lowing were the factors that led to the big house price fluctuations in U.S. Then the collapse of house prices in U.S. triggered the global economy crisis. Bernanke, Boivin and Eliaz (2005), and Mumtaz and Surico (2009) studied of the impact of international transmission mechanism, probing of macroeconomic variables with cross-border mobility connection.

This paper, by using 3 major economies of the Asian region, Hong Kong, China, Taiwan and the United States as the objects, analyses fluctuations, path and influence of transmission of house prices, interest rates and macro-economy. This paper is divided into four parts, the first one is introduction, the second is to use price index, interest rates, stock index and the GDP growth rate of the United States, Hong Kong, China and Taiwan to run the VAR model and VECM model. The third is the empirical analysis. Finally, the paper concludes.

2 Theoretical Model

Sims (1980) proposed the VAR (vector autoregression) model. We referred Bonnie (1998), Hui and Yue (2006) to constructed VAR model. Variable information is the price index, stock indices, interest rates and real GDP growth rate. Using time series theoretical model and empirical methods studies the influence of house prices, interest rates, and macro-economy. VAR model is determined as follows:

$$Y_t = C + \sum_{i=1}^{q} A_i Y_{t-i} + \varepsilon_t \tag{1}$$

Where, Y^{t} is to be investigated variables which is (n×1) endogenous variable vector, Y^{t-i} is Y^{t} to the amount of the first i-deferred items consisting of (n×1) vector, A is (n×n) of the coefficient matrix, ε_t is (n×1) vector composed of one-time forecast error.Engle and Granger (1987) proposed random walk of individual variables, even non-stationary, but if the correlation of Cointegration exists between variables. Then, each sequence of variables would integrate into a stable sequence. In long time, the linear combinations between the variables will base on short-term dynamic adjustment to achieve the long-run equilibrium. Granger's representative Theorem is Vector Error Correction Model(VECM). VECM's theorem is that for any cointegration relationship existing variable group I (1), VECM applies. VAR model adds error correction items to be the Cointegration - error correction model, as follows (2):

$$\begin{aligned}
&\Delta Y_t = \Pi Y_{t-P} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots \Gamma_{k-1} \Delta Y_{t-(P-1)} + \varepsilon_t ,\\
&\Pi = (\sum_{i=1}^{p} A_i) - I_k ,\\
&\Gamma_i = (\sum_{j=1}^{i} A_j) - I_k
\end{aligned} \tag{2}$$

Equation (2) is a first differentiation VAR model with error correction item Y_{t-p}, I is unit matrix. Γ_i is measurable short-term impact. But, $\Pi = \alpha\beta^{'}$ can be used to measure long-term effects. α is the error correction adjustment speed. In the non-equilibrium state, the greater of the α means that the adjustment of the average speed faster. β is the co-integration vector (cointegration vector) matrix. The rank of $\hat{\prod}$ determines the number of cointegration vectors.

Johansen (1988, 1991) uses Gaussian vector autoregressive model, the unrestricted and Gaussian errors included model, that is called maximum likelihood method.. Use the corresponding error correction equation of the model to be the maximum likelihood estimation basis, and use the statistics of two likelihood test ration to confirm the number of cointegration vectors. Use the maximum likelihood function to estimate $\hat{\Pi}$, and find out the root of characteristics. $\hat{\lambda}$ Then, use the matrix of rank to test the existing of cointegration among variables. The tests of statistics are the Trace test (3)and the Maximum Eigenvalue Test(4).

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i) \tag{3}$$

$$\lambda_{\max}(r, r+1) = -T\, ln(1-\hat{\lambda}_{r+1}) \tag{4}$$

T is total number of samples. $\hat{\lambda}_i$ is the i estimate of the ith eigenvalue. r is the number of cointegration vectors. When the value of trace test or the maximun eigenvalue test is very large, reject the null hypothesis.

3 Empirical Analysis

3.1 Basic information

This paper studies major variables of the United States, China, Hong Kong and Taiwan. For U.S., FAHA housing price indexes (USH), Dow Jones Industrial Average Stock Index (USS), the FED basic interest rate (USI), real GDP growth rate (USGDP). For China, Real Estate Climate Index Sales Price Index (CHH), Shanghai A Share Index (CNS), the People's Bank base rate (CNI), real GDP growth rate (CNGDP). For Hong Kong, private residential price index (HKH), the Hang Seng Index (HKS), Bank Base Rate (HKI), real GDP growth rate (HKGDP). For Taiwan, Sin-Yian House Price Index (TWH),the weighted stock price index (TWS), the discount rate (TWI), real GDP growth rate (TWGDP). Samples taken period is from the first quarter of 1998 to the third quarter of 2010, amount to 51 quarters of data.

Table 1 shows the coefficient matrix of variables of United States, China, Hong Kong and Taiwan. The correlation coefficients of the house price index to GDP growth rate and the Hang Seng index were 0.55 and 0.45,the house price index to the GDP growth rate was0.70, the Shanghai A Share Index and the GDP growth rate was 0.5.For Taiwan, the correlation coefficient of the house price index to re-discount rate was negatively correlated ,the weighted stock price index to the GDP growth rate was 0.44.

Table 1 Correlation coefficient matrix

		house	Interest rate	Stock index	GDP
US	USH	1	0.322149	0.051468	0.45497
	USI	0.322149	1	0.381701	0.563358
	USS	0.051468	0.381701	1	0.228104
	USGDP	0.45497	0.563358	0.228104	1
HK	HHH	1	-0.3295	0.545588	0.452491
	HKI	-0.3295	1	-0.08146	-0.07788
	HKS	0.545588	-0.08146	1	0.42736
	HKGDP	0.452491	-0.07788	0.42736	1
CN	CNH	1	0.100832	0.256246	0.698092
	CNI	0.100832	1	0.354141	0.185672
	CNS	0.256246	0.354141	1	0.498969
	CNGDP	0.698092	0.185672	0.498969	1
TW	TWH	1	-0.48384	0.218059	0.372364
	TWI	-0.48384	1	0.388695	0.038071
	TWS	0.218059	0.388695	1	0.443699
	TWGDP	0.372364	0.038071	0.443699	1

3.2 Unit Root Test and the Best Selection of Lagged Period

To avoid the phenomenon of spurious regression generated in the progress of the empirical analysis model, , Augmented Dickey-Fuller (ADF) test and Phillips-Perron test unit root test are used.: If the test results significantly, reject the null hypothesis.. After the AIC criteria selecting the optimal lag periods of ADF unit root test, the test results of ADF and PP unit root test of variables of house price indices, interest rates, stock prices and GDP growth rate showed that except U.S. house price index was a stationary series in

the second order differentiation, the rest all showed significant phenomenon. Therefore, reject the null hypothesis of unit root, stationary data.
Under AIC criterion, the optimal lagged periods for the four countries of the VAR model were one for United States, four for Hong Kong, three for China, and four for Taiwan as in Table 2.

Table 2 VAR Model Optimal Common Lag Length

Lag	Lag	LogL	LR	FPE	AIC	SC	HQ
US	0	88.80956	NA	2.71E-07	-3.76931	-3.608721*	-3.709447*
	1	107.0487	32.42522	2.46e-07*	-3.868833*	-3.06587	-3.5695
	2	118.3715	18.11641	3.09E-07	-3.66096	-2.21563	-3.12215
	3	127.2618	12.64398	4.43E-07	-3.34497	-1.25727	-2.5667
	4	153.1643	32.23417*	3.12E-07	-3.78508	-1.05501	-2.76734
HK	0	-51.2298	NA	0.00013	2.401297	2.560309*	2.460864
	1	-24.4694	47.70335	8.15e-05*	1.933453	2.728514	2.231288*
	2	-16.1039	13.45752	0.000116	2.265388	3.696499	2.801491
	3	-0.0374	23.05199	0.00012	2.262495	4.329655	3.036866
	4	25.2758	31.91663*	8.72E-05	1.857574*	4.560783	2.870212
CHINA	0	60.13587	NA	1.02E-06	-2.44069	-2.281678*	-2.381123*
	1	74.74197	26.03697	1.09E-06	-2.38009	-1.58502	-2.08225
	2	89.81143	24.24217	1.16E-06	-2.33963	-0.90852	-1.80353
	3	113.9607	34.64897*	8.46e-07*	-2.693944*	-0.62678	-1.91957
	4	125.1193	14.06957	1.14E-06	-2.48345	0.21976	-1.47081
TAIWAN	0	-37.9636	NA	7.29E-05	1.824502	1.983514*	1.884069
	1	-7.99086	53.42957	3.98E-05	1.216994	2.012055	1.514829
	2	8.835784	27.06895	3.91E-05	1.181053	2.612164	1.717156
	3	24.7892	22.88969	4.09E-05	1.183078	3.250238	1.957449
	4	56.53438	40.02653*	2.24e-05*	0.498505*	3.201714	1.511143*

3.3 Vector Autoregression Model

Take the United States as the sample. The vector autoregression of the house prices, interest rates, stock prices and the GDP growth rate is $VAR_i(k)$,i=US、CN、HK、TW, The equation is as follows：

$$
\begin{aligned}
USH_t &= \sum_{i=1}^{K} \beta_i^{USH} USH_{t-i} + \sum_{i=1}^{K} \beta_i^{USI} USI_{t-i} + \sum_{i=1}^{K} \beta_i^{USS} USS_{t-i} + \sum_{i=1}^{K} \beta_i^{USGDP} USGDP_{t-i} + C^{USH} + \varepsilon_t^{USH} \\
USI_t &= \sum_{i=1}^{K} \beta_i^{USH} USH_{t-i} + \sum_{i=1}^{K} \beta_i^{USI} USI_{t-i} + \sum_{i=1}^{1} \beta_i^{USS} USS_{t-i} + \sum_{i=1}^{K} \beta_i^{USGDP} USGDP_{t-i} + C^{USI} + \varepsilon_t^{USI} \\
USS_t &= \sum_{i=1}^{K} \beta_i^{USH} USH_{t-i} + \sum_{i=1}^{K} \beta_i^{USI} USI_{t-i} + \sum_{i=1}^{K} \beta_i^{USS} USS_{t-i} + \sum_{i=1}^{K} \beta_i^{USGDP} USGDP_{t-i} + C^{USS} + \varepsilon_t^{USS} \\
USGDP_t &= \sum_{i=1}^{K} \beta_i^{USH} USH_{t-i} + \sum_{i=1}^{K} \beta_i^{USI} USI_{t-i} + \sum_{i=1}^{K} \beta_i^{USS} USS_{t-i} + \sum_{i=1}^{K} \beta_i^{USGDP} USGDP_{t-i} + C^{USGDP} + \varepsilon_t^{USGDP}
\end{aligned}
\tag{5}
$$

U.S. housing market index was significantly affected by its own variables one period ahead. The interest rate was significantly affected by its own variables one period ahead and also significantly influenced by the Dow Jones Industrial Average Stock Index one period ahead. GDP growth rate was significantly affected by the Dow Jones Industrial Average Stock Index one period ahead and was significantly affected by its own variables one period ahead.

The housing market index of Hong Kong was significantly affected by interest rate three periods ahead, and by the Hang Seng Index one period and four periods ahead. Interest rates was significantly affected by housing market index two period ahead, by its own variables one period ahead, by the Hang Seng Index three period ahead, and by GDP growth rate one period ahead.

China housing market index was significantly affected by the Shanghai A Share Index two and three periods ahead. Interest rates was significantly affected by the Shanghai A Share Index one and three periods ahead, and by GDP growth rate three periods ahead. The Shanghai A Share Index was significantly affected by the China housing market index one, two, and three periods ahead, by its own variables three periods ahead, and by the GDP growth rate one and two periods ahead.

Taiwan housing market index was significantly affected by its own variables three and four period ahead, by interest rate one and two periods ahead, by the weighted stock price index four periods ahead, and by GDP growth rate two period ahead. The interest rate was significantly affected by the housing market index three period ahead. by its own variables one and four periods ahead, and by the Taiwan weighted stock index variables one, two, three, and four periods ahead.

3.4 Cointegration and Vector Error Correction Model

We uses Johansen cointegration test method, two kinds of statistics of the Trace Test and the Max-Eigen Statistic, to test the number of cointegration vectors. Table 3 is the analysis results of the Johansen cointegration test. The number of lagged period is one. From the results of Table 3 of the Trace Test and the Max-Eigen Statistic, there is no cointegration vectors.

The test results in Table 3 shows that at 1% significance level, variables such as the house price index, interest rates, stock market index and GDP growth rate of the United States, China, Hong Kong, and Taiwan, rejected the null hypothesis. That means that there is a cointegration relationship for the housing price index, interest rates, stock index and the GDP growth rate of the United States, Hong Kong, China, and Taiwan. It also indicates that the housing price index, interest rates, stock index and the GDP growth rate of the

United States, Hong Kong, China, and Taiwan have long-term stable equilibrium relationships.

Table 3: Johansen Cointegration Test

National	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value(0.05)	Max-Eigen Statistic	Critical Value(0.05)
US	r=0	0.520816	52.22312 ***	40.17493	34.57657 ***	24.15921
	r≦1	0.266851	17.64656	24.27596	14.58909	17.7973
	r≦2	0.055508	3.057465	12.3209	2.684084	11.2248
	r≦3	0.007913	0.373381	4.129906	0.373381	4.129906
HK	r=0	0.435106	46.22977 **	40.17493	27.98475 **	24.15921
	r≦1	0.175457	18.24501	24.27596	9.453361	17.7973
	r≦2	0.156375	8.791653	12.3209	8.332325	11.2248
	r≦3	0.00933	0.459328	4.129906	0.459328	4.129906
CHINA	r=0	0.660548	105.5657 ***	63.8761	51.86025 ***	32.11832
	r≦1	0.434064	53.70546 ***	42.91525	27.32518 **	25.82321
	r≦2	0.26745	26.38029	25.87211	14.93872	19.38704
	r≦3	0.212086	11.44157	12.51798	11.44157	12.51798
TAIWAN	r=0	0.515137	65.28914 ***	54.07904	35.47057 ***	28.58808
	r≦1	0.275812	29.81857	35.19275	15.81249	22.29962
	r≦2	0.178007	14.00608	20.26184	9.605138	15.8921
	r≦3	0.0859	4.400938	9.164546	4.400938	9.164546

Note: *** ， ** ， * Significant at the 1%， 5%， 10% level.

Table 4 is the cointegration of the normalized cointegration coefficients and adjustment coefficients. The cointegration vectors of U.S. house prices index are (1, -0.050675, 0.4842, 0.13496), The U.S. FED basic interest rate decreased by 1% would result in that house price index rose by 0.05%. The Dow Jones Industrial Average rose by 1% quarterly would result in that the house price index increased by 0.48%. GDP growth rate increased by 1% would push the house price index up by 0.13%. Adjustment coefficients vectors were (-0.00725, -0.16041, 0.067322, 3.682663). When the U.S. house price index, interest rates, stock index and the GDP growth rate deviated from the long-term equilibrium relationships, U.S. house prices and interest rates would fall restore long-term equilibrium, and the stock price index and GDP growth rate would rise to restore long-term equilibrium.

For Hong Kong, cointegration vectors were (1, -0.1211, 0.50857, 0.10507). Bank base rates decreased by 1% would make house price index rise by 0.12%. Hong Kong Hang Seng Index rose 1% quarterly would make house price index increase by 0.51%. GDP growth rate rose by 1% would make house price index rise by 0.11%. Adjustment coefficients vectors were (-0.00109,-0.12817,0.08198,2.64313), When Hong Kong house price index, interest rates, stock index and GDP growth rate
deviated from the long-term equilibrium relationship, the interest rates would fall, and house price index, stock index and GDP growth rate would increase to adjust to restore the long-term equilibrium.

For China, cointegration vectors were (1, -0.048976 ,0.03015, 0.02847). China People's Bank base rate increased by 1% would cause house price index fall by 0.05%. Shanghai A Share Index rose by 1% would make house price index rise by 0.03%. GDP growth rate rose by 1% would make house price index increase by 0.03%. adjustment coefficients

vectors were (-0.19216, -10.0783, -3.51064,13.79321). When China house price index, interest rates, stock index and GDP growth rate deviated from the long-term equilibrium relationships, the China house price index, interest rate, and stock price index would fall to restore a long-term equilibrium. GDP growth rate would increase to adjust to restore the long-term equilibrium.

For Taiwan, cointegration vectors were (1, -0.043039, 0.04868, 0.02055). The re-discount rate of the Central Bank fell by 1% would make house price index change by 0.05%. The weighted stock price index rose by 1% quarterly would push house price index up by 0.05%. GDP growth rate changed by 1% would make house price index rise by 0.02%. Adjustment coefficients vector were (-0.3489,0.374409, -0.21764, -13.6976). When the housing price growth rate, interest rates, stock index and GDP growth rate deviated from the long-term equilibrium relationships, the housing price index, stock index and GDP growth rate would fall to restore the long-term equilibrium, and interest rate would rise to restore the long-run equilibrium.

Table 4: Normalized cointegrating coefficients and Adjustment coefficients

	Normalized cointegrating coefficients			Adjustment coefficients			
USH	USI	USS	USGDP	D(USH)	D(USI)	D(USS)	D(USGDP)
	-0.0506	0.4884	0.1349	-0.0072	-0.1604	0.0673	3.6826
	[2.5708]***	[-86.4243]****	[-5.7172]****	[-0.6197]	[-0.2703]	[0.7129]	[5.4539]****
HKH	HKI	HKS	HKGDP	D(HKH)	D(KHI)	D(KHS)	D(KHGDP)
1	-0.1211	0.5085	0.1050	-0.0011	-0.1281	0.0819	2.6431
	[2.2507]***	[-12.9172]****	[-5.0691]****	[-0.0422]	[-1.1184]	[2.5005]***	[4.8884]***
CNH	CNI	CNS	CNGDP	D(CNH)	D(CNI)	D(CNS)	D(CNGDP)
1	-0.048976	0.03015	0.02847	-0.19216	-10.0783	-3.51064	13.79321
	[6.92325]****	[-2.3550]****	[-12.1312]****	[-1.6934]**	[-5.8357]****	[-3.1165]****	[1.82527]**
TWH	TWI	TWS	TWGDP	D(TWH)	D(TWI)	D(TWS)	D(TWGDP)
1	-0.043039	0.04868	0.020548	-0.3489	0.374409	-0.21764	-13.6976
	[3.18055]****	[-0.51719]	[4.62421]****	[-4.9594]****	[1.02099]	[-0.93216]	[-3.4517]****

Note:[ ] T-statistic value; *, **, ***, **** Significant at the 20% ,10% ,5%, 1% level.

3.5 Granger-Causality Test

This paper uses VAR-Granger-Causality test to study the influence effects of the housing market, interest rates, stock market and macro-economy for the United States, Hong Kong, China and Taiwan.

Table 5 shows the Granger-Causality effects among variables under known degree of freedom and Chi-square test. The fluctuations of the housing markets of Taiwan and Hong Kong were helpful to predict the housing markets of U.S. and China. The housing market of Taiwan was also helpful to predict the housing market of Hong Kong. For interest rate volatility effects, there was a mutual predictable function between United States and Taiwan, and between the United States and China. The interest rates of Taiwan and China were helpful to predict the interest rate of Hong Kong. But, the interest rates of Taiwan and China were significantly affected by the interest rate fluctuations of the United States. For the stock market, quarterly data of stock markets of Taiwan and China

were helpful to predict stock market fluctuations of U.S. and Hong Kong. Also, the U.S. stock market could significantly predict the Hong Kong stock market. The changes of U.S. GDP growth rate could significantly predict the changes of GDP growth rates of China, Hong Kong and Taiwan. Besides, the changes of China GDP growth rate also could significantly predict the changes of GDP growth rate of Hong Kong.

Table 5: Granger-Causality effect

Dependent variables	Excluded （Chi-sq）
HKH	CNH（7.488059）*，TWH（7.851566）*
USH	HKH（10.26824）**，
CNH	HKH（14.56246）***，TWH（23.99512）***
TWI	USI (10.04117）**
HKI	CNI（10.09724）**，TWI（7.580176）*
USI	CNI（7.893208）**，
CNI	USI（9.179462）**，TWI（10.01049）**
HKS	TWS（7.938505）****，USS（5.394882）**，CNS（6.206854）****
USS	CNS（5.375485）*，
TWGDP	USGDP（18.74125）***
HKGDP	USGDP（13.77904）***，CNGDP（8.22907）*
CNGDP	USGDP（15.83863）***

4 Conclusion

Whether the real estate has the comovement effect between countries? This paper, by taking 3 major economic objects of the Asian region for Hong Kong, China and Taiwan, and the United States as the fourth objects of this study, analyses the macroeconomics and influence of house prices, interest rates and macro-economy. Samples taken period is from the first quarter of 1998 to the third quarter of 2010, amount to 51 quarters of data.

This paper finds that the changes of U.S. GDP growth rates are helpful to predict the volatility of GDP growth rates of China, Hong Kong and Taiwan. And, the regional-based GDP growth rates can significantly affect the price index of the three objects. The changes of China stock market indexes could significantly predict the changes of U.S and Hong Kong stock indexes. And, all regional stock price indexes all have significant effects to house price indexes. The interest rates of Taiwan and China are helpful to predict the interest rate of Hong Kong. The impacts of the changes of interest rates to the house price indexes showed a negative signal for each area. For the housing market index, the housing price index of Taiwan and Hong Kong could be used to predict the house price fluctuations of China. There is a significantly mutual predictable function among Hong Kong, Taiwan and China for the volatility effects of house price indexes.

Since it is difficult to obtain international data, this paper has given up more samples of monthly data and changed to quarterly data as analysis samples. But, because of data limitation, some results are not significant and it retards further exploring and making further conclusions.

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