2011 International Conference on Social Science and Humanity
IPEDR vol.5 (2011) © (2011) IACSIT Press, Singapore

Interest rate, Unemployment rate,and House Market in US

Jen-Shi Ni
Department of Finance and Taxation.,
Takming University of Science and Technology,
Taipei 11451, Taiwan,
jenshi@takming.edu.tw

Shuen- Shi Huang
Department of Public Finance ,
Ling Tong University ,
Taichung ,
40852, Taiwan,
Sunhsi49@ms37.hinet.net

Yu Wen
graduated in Department of Accountancy
Taipei University ,
Taipei 11451, Taiwan,
elise@takming.edu.tw

Abstract—**The aim of this paper is to find out the relation between interest rate and unemployment rate variables with house market index in US, because global economic crisis due to sub-prime mortgage financial crisis in 2008. This paper use time series method of forecasting volatility of housing market index in the US. We construct VAR model including variables, housing market index, unemployment rate, consumer confidence index, the Dow Jones industrial index, FED interest rate and so on. We founded the house market index in US will be changed 11.7 due to unemployment rate,0.49 due to consumer confidence index， -11.04 due to FED interest rate， 0.3% due to Dow Jones industry index, per one unit change. There are also have long run stable relation between the variables.**

Keyword: Subprime Mortgage Crisis, VAR ， House Market Index，VECM， Cointegration.

I. INTRODUCTION

Since the busting of the US bubble in 1999, the Federal Reserve have been cutting interest rates for the consecutive time, which the federal funds rate dropped from 6.5% to 1%. But the subprime mortgage market rapidly expanded due to the fell in market interest rates, which total assets reached USD 640 billion high in 2006. At the same time, the Dow Jones Industrial Average rose from 8,053 to 12,621 since the end of 2002 to the end of 2006. However, this low interest rate environment changed after 2004, the Fed raised interest rates several times consecutively from 2004 to 2006, which the interest rate was adjusted from 1% to 5.25%. The rise in interest rates increased the burden of borrows. In 2007, New Century Financial filed for bankruptcy, American Home Mortgage (AHM), Bear Stearns, Lehman Brothers, Merrill Lynch, AIG for bankruptcy in 2008. The global economy into recession, shrinking trade, industrial production declined sharply, rising unemployment.

Case(2000), Sutton (2002) and Terrones and Otrok(2004) have studied global macroeconomic effects on real estate prices. Real estate markets appear to be highly correlated internationally. Adam and Fuss(2010) explains the impact of the macroeconomy on house prices. Andrea and Claudio (2010) pointed out the global macroeconomic and financial shocks can be largely interpreted in terms of US macroeconomic and financial shocks.US subprime crisis triggered global financial turmoil, the economic and thus fell. When will the US housing market recovering from the bottom, it will be the focus of national attention? Based on US housing market index, the unemployment rate, consumer confidence index, Dow Jones industrial index, FED interest rate construction VAR model, data periods form 1994M1 to 2010M10. This article will explore the fundamentals and other variables affect the housing market index level, then by the Unit root test of Johansen's cointergration test, by the error correction model (VECM) test, predicted the US housing market volatility. We want to find out the fluctuation of house market in US

Some studies used time series and the VAR model to discuss housing estates, such as Zellner and Palm (1974). Bonnie (1998) established a VAR model by using the variables in number of home sales, housing prices, loan rates, the SCI, employment rate changes and HIS in 1973 through 1974 to analyze housing sales and price fluctuations in the entire U.S and east, west, south and north regions. The results confirmed that the number of home sales and price changes significantly affected economic fundamentals; regional housing sales and prices will affect regional employment and prices, and national interest rates and HIS had an influence in national employment and economy. Dua et al. (1999) used variables in housing sales, housing prices, housing interest rates, real disposable income, Hong Kong’s residential sales index, and the VAR and Bayesian VAR model to predict three phases of US home sales. Matteo Iacoviello (2005) used real GDP, GDP deflator, real housing prices, a VAR model based on FED interest rate to confirm the relationship between housing prices and the business cycle, or in other words the impact in housing prices and requirements have the same directional relation in variations. Eddie and Yue (2006) established a VAR model based on the variables of housing price index, urban disposable income, and regional GDP and SCI, and used the vector error correction model (VECM) to analyze the housing price bubble in Hong Kong, Beijing and Shanghai. Gupta et al. (2008) used the VAR theory to predict the house prices in six regions of South Africa, and via VAR and the Spatial Bayesian VAR model to out-of-sample forecast the housing prices for six major metropolitan areas. Hott and Monnin (2008) considered that fundamental factors can enhance long-term house price forecasts for housing prices, and established a fundamental model in supply and demand to estimate housing prices in the real estate market. The price forecast was conducted by comparing the variables in the incomes of the US, Britain, Japan, Switzerland and the Netherlands, SCI, interest rates, rents and buildings, which were confirmed by VAR, the cointegration test and impulse-response function.

The study is divided into four parts: Section 1 is an introduction of this study; Section 2 established a VAR model and VECM model for the US house market index . Section 3 provides the empirical research results and analysis. The conclusions are given in the last section.

II. METHDOLOGY

We referred to the models of Quigley (1999), Eddie and Yue (2006) and Goetzmann, Peng and Yen,(2009) . Supply sides and demand sides factors were considered to forecast the fluctuation in they research. Eddie and Yue (2006), use income 、interest rate 、price level and house construct to analysis the house price fluctuation. In this paper, We use the house market index, unemployment rate, consumer confidence index, Dow Jones Industrial index, FED interest rate contract to construction model as follow:

$$Y_t = C + \sum_{i=1}^{p} \beta_i Y_{t-j} + \varepsilon_t \quad (1)$$

where β_i to β_p is a k×k size matrix, $Y_t = (Y_{1t,} Y_{2t,} .. Y_{kt})'$ is a k×1 size vector, C is a k×1 size intercept vector, ε_t is a k×1 random variable vector with white noise properties. The above equation is expressed as a VAR(1) matrix into (2), which coefficient β_p^{mn} indicates the lag for the p^{th} , and the degree of influence with the n^{th} variable towards the m^{th} variable.

$$\begin{bmatrix} HMI_t \\ UMR_t \\ FED_t \\ CCI_t \\ DWI_t \end{bmatrix} = \begin{bmatrix} C^{HMI} \\ C^{UMR} \\ C^{FED} \\ C^{CCI} \\ C^{DWI} \end{bmatrix} + \begin{bmatrix} \beta_1^{11} & \beta_1^{12} & \beta_1^{13} & \beta_1^{14} & \beta_1^{15} \\ \beta_1^{21} & \beta_1^{22} & \beta_1^{23} & \beta_1^{24} & \beta_1^{25} \\ \beta_1^{31} & \beta_1^{32} & \beta_1^{33} & \beta_1^{34} & \beta_1^{35} \\ \beta_1^{41} & \beta_1^{42} & \beta_1^{43} & \beta_1^{44} & \beta_1^{45} \\ \beta_1^{51} & \beta_1^{52} & \beta_1^{53} & \beta_1^{54} & \beta_1^{55} \end{bmatrix} \begin{bmatrix} HMI_{t-1} \\ UMR_{t-1} \\ FED_{t-1} \\ CCI_{t-1} \\ DWI_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^{HMI} \\ \varepsilon_t^{UMR} \\ \varepsilon_t^{FED} \\ \varepsilon_t^{CCI} \\ \varepsilon_t^{DWI} \end{bmatrix} \quad (2)$$

The VAR model of (2) can be rearranged into a modified cointegration-error model in (3) after adding an error correction term:

$$\Delta Y_t = \Pi Y_{t-P} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + .. \Gamma_{k-1} \Delta Y_{t-(P-1)} + \varepsilon_t \quad (3)$$

where, $\Pi = (\sum_{i=1}^{p} A_i) - I_k$, $\Gamma_i = (\sum_{j=1}^{i} A_j) - I_k$

The above equation is a differential VAR model added with an error correction term Y_{t-p}, in which I is a unit matrix, Γ_i is used to evaluate short-term effects, and $\Pi = \alpha\beta'$ is used to evaluate long-term effects. An adjustment coefficient matrix is indicated by α, representing the cointegration weight. The cointegration vector is indicated by β, and the rank of Π determines the number of cointegration vectors. The analysis can be divided into the following three situations:

- If rank(Π)=k, Π is a full rank, and represents all variables of vector series Y_t are stationary.
- If rank(Π)=0, vector series Y_t does not exist a cointegration relation, and (3) reduces into an ordinary one-order differential VAR model.
- If 0< rank(Π)=r<k, vector series Y_t exists a total of r cointegration vectors,

$\Pi = \alpha\beta'$,α is the adjustment coefficient matrix which represents the weight size in the cointegration relation, and β' is the cointegration vector which enables the nonstationary Y_t becomes stationary after $\beta' Y_t$ linear assembly.

The approach used its corresponding error correction representation to likely estimate as the basis, and two likelihood test rations to determine the number of cointegration vectors. The method then used the maximum likelihood function estimation $\hat{\Pi}$ to find the eigenvalues $\hat{\lambda}$, and used the matrix rank to test if the variables exist a cointegration relation. The statistic testing used the trace test and maximum eigenvalue test. The trace test and maximum eigenvalue test can be expressed by .(4), (5):

$$\begin{cases} H_0 : rank(\Pi) \le r \\ H_1 : rank(\Pi) > r \end{cases} \quad \lambda_{trace}(r) = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda}_i) \quad (4)$$

$$\begin{cases} H_0 : rank(\Pi) = r \\ H_1 : rank(\Pi) = r+1 \end{cases} \quad \lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (5)$$

which r is the number of cointegration vectors, $\hat{\lambda}$ is the i^{th} estimated eigenvalue of the matrix. When the value of the trace test or maximum eigenvalue test is very large, the null hypothesis is then rejected.

III. EMPIRICAL ANALYSIS

A. Basic data

The house price index data used in this study included HMI,UMR,FED,CCI, DWI The data source was from DATASTREAM database. The time periods was from 1994M1 to 2010M10. The described statistics of variables are listed in TABLE 1

Table 1

	HMI	UMR	FED	CCI	DWI
Numbers	202	202	202	202	202
Mean	50.39109	5.59703	3.612772	98.7698	9148.911
Max	78	10.1	(3) 6.54	144.7	13930.01
Min	8	3.8	0.11	25.3	3624.96
St. deviation	19.62587	1.520013	2.064749	27.41992	2532.455
Skewness	-0.8155	1.702657	-0.4259	-0.50532	-0.66821
Kurtosis	2.310758	5.248094	1.658034	2.730488	2.735975
J-B value	26.38806***	140.1383***	21.2641***	9.20815***	15.6191***

Q(4)	740.66***	721.75***	758.31***	701.87***	723.06***
Q(8)	1369.8***	1253.6***	1358.4***	1271.8***	1293.0***

Note: Q(4) and Q(8) indicates lag 4 and lag 8 in the Ljung-Box test; ***, ** *indicates significance at 1%, 5%, 10% level, respectively

B. Unit root test

To avoid the generation of any spurious regression within the empirical research, the data must be selected in an integrated order according to the variables time series by the unit root, as in order to assure stationary data series. After the unit root test, the data were all of an I(1) series, which was then able to determine if the data existed a cointegration relation. To guarantee the stability of time sequence data, the Augmented Dickey-Fuller (ADF) test and Phillips-Perron unit root test were applied in this study.

C. VAR ,Cointegration and VECM

The selection for optimal number of lags in the VAR model for the housing market index have five conditions, i.e. LR, FPE, AIC, SC and HQ. Table 2 lists the results, we applied the AIC criteria and selected lag 2 as the optimal number of lags in the VAR model.

Table 2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3906.37	NA	2.24E+11	40.32343	40.40765	40.35754
1	-2341.52	3032.919	28547.63	24.44862	24.95395	24.65324
2	-2264.51	145.2805	16708.7*	23.9124*	24.8389*	24.2876*
3	-2244.46	36.79475	17605.69	23.96349	25.31106	24.50915
4	-2230.85	24.2633	19847.62	24.08097	25.84965	24.79716
5	-2213.73	29.6573	21609.62	24.16217	26.35197	25.04888

The study used the Johansen cointegration test method, and by trace test and maximum eigenvalue (ME) test statistics to determine the number of cointegration vectors and lag2 . Table 3 lists the analysis results of the Johansen cointegration. From the trace test and ME Statistic, it could be seen that for the null hypothesis: H_0, r=0, and has no cointegration vector. The test results had discovered that the five variables rejected null hypothesis at a 1% significance level and occurred with cointegration relations. The result indicated that the housing market of US, HMI,UMR,CCI,FED and DWI had a long and stable equilibrium relation.

The normalized cointegration coefficients and correction coefficients for cointegration are listed in TABLE 3. The cointegration vector is (1, -11.72556, 0.4949,. -11.03747, 0.003664). Every variation of the UMR caused -11.726 change in US housing market index, increase in CCI increase 0.49 in US house market index, change in FED will -11.04 change in house market in US., change in DWI increase 0.3% change in house market index. Compare the results with Adam and Fuss(2010), an increase in the long-term interest rate mmakes other fixed-income assets more attractive relative to residential property investment, reducing the demand for this kind of investment which in turn lowers house prices by 0.3% in the long run.

Table 3

Normalized cointegrating coefficients					
HMI	UMR	CCI	FED	DWI	C
1	-11.72556	0.4949	-11.03747	0.003664	140.379
	[6.67468]***	[-4.52518]***	[9.22527]***	[6.22033]***	
Adjustment coefficients					
D(HMI)	D(UMR)	D(CCI)	D(FED)	D(DWI)	
-0.03967	-0.00694	0.054927	-0.00092	6.602399	
[-1.55707]*	[-5.27518]***	[0.98704]	[-0.63584]	[1.61380]*	

Note: Values inside [ ] are the t-test values

VECM can be used to discuss the short-run dynamic adjusting effect among the variables(Engle and Granger (1990). Table 3 shows the short and long-term effects in the cointegration correction error model for each variable. The error-correction coefficient vector was (-0.03967,-0.00694, 0.054927, -0.00092, 6.602399), which respectively represents the adjustment coefficient of HMI , UMR,CCI , FED, DWI. When US housing market deviated from the long-term equilibrium relation, they fell back to the long-term equilibrium.

D. IRF and variance decomposition prediction

A VAR(P) impulse response function(IRF) in a matrix form as follow

$$y_t = \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \cdots + \Phi_p y_{t-p} + \varepsilon_t \tag{6}$$

where Φ_j is an IRF, $\varepsilon_t \sim iid(0,\sigma^2)$

Ten periods of variations and the effects were conducted from the variable changes of one standard deviation unit (Choleski decomposition). The impulse response effect among the variables could be observed in Fig. 1. The accumulated response of house market index showed left side and unemployment rate showed right side on the first column, and so on. The response of house market index is first period ,consumer confidence decrease from 2 periods until 4 periods, Dow Jones index until 3 periods, Fed interest rate decrease 2 periods until 8 periods to unemployment rate disturbance. From the consumer confidence index disturbance, the impulse of house market index, Dow Jones index and unemployment rate are 3 periods, Fed interest rate is 5 periods. From Fed interest rate disturbance, the response of house market index , consumer confidence index and Dow Jones index are 4 periods, unemployment rate until 6 periods。From Dow Jones index disturbance, the response of house market index and Fed interest rate 4 periods, unemployment rate and consumer confidence index until 3 periods. The house market index has only 1 period impulse effect in house market and Fed interest.

The variance decomposition uses the individual variables in the VECM model to predict error variance. The decomposition comes from the innovation ratio of different variables. The prediction error variance is given as

$$Var[Y_{t+n} - E_t(Y_{t+n})] = Var\left[\sum_{j=0}^{n-1} \Phi_{ijs} e_{t-j}\right]$$

$$R_{jin}^2 = \frac{\sum_{s=0}^{h-1} \Phi_{ijs}^2 \sigma_j^2}{\sum_{j=0}^{n-1} \sum_{s=0}^{h-1} \Phi_{ijs}^2 \sigma_j^2} \quad (7)$$

The expression in (7) is used to forecast error variance impact of the jth exogenous variable, $e_{j,t}$ to $Y_{i,t}$. Fig 2 shows the forecast error variance decomposition of the US housing market. The main variance of house market index are Dow Jones index and FED interest rate except itself, they interpret variance of house market index up to 8% and 4% in US.FED interest rate explains the variance of unemployment increase to 10% after 2 periods. In consumer variance, was decrease to 83% from itself interpretation, however, increase to 13% form Dow Jones index disturbance. Consumer confidence index explains the variance of FED interest rate increase 10% after 2 periods. The most variance of Dow Jones index is itself, 90%, the second is consumer confidence index , only 5%

E. Garnger- Causality test

We use VAR-Granger-Causality test to discuss the Granger-Causality effect between variables. With chi-square test and 2 degree of freedom , the Granger-Causality effect were listed in table 3. Consumer confidence index , FED interest rate and Dow Jones are Granger cause house market index in US. However, house market index , FED interest rate and Dow Jones index have Granger cause unemployment rate. House market index ,FED interest rate, Dow Jones index also have Granger cause consumer confidence index 。

Table 3

Dependent variable	Excluded	Chi-sq	Df	significant
HMI	CCI	8.063354	2	*
	FED	19.14859	2	***
	DWI	27.52778	2	***
UMR	HMI	15.9864	2	***
	FED	20.21905	2	***
	DWI	7.051096	2	*
CCI	HMI	9.586661	2	**
	FED	8.848794	2	*
	DWI	31.98735	2	***

Note: ***, ** *indicates significance at 1%, 5%, 10% level, respectively

IV. CONCLUSION

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. The financial crisis burst in 2008 caused the plunges in global equity and currency markets, and an economic crisis among nations. There are five variables, house market index, unemployment rate, consumer confidence index, the Dow Jones index, FED interest rate to construct VAR model, cointegration test, VECM test, predicted the US housing market volatility data from 1994M1 to 2010M10.

The empirical results are as follows. We founded the house market index in US will be changed 11.7 due to unemployment rate , 0.49 due to consumer confidence index, -11.04 due to FED interest rate , 0.3% due to Dow Jones industry index, per one unit change. There are also have long run stable relation between the variables.

Future research, the housing market maybe included other Asia Pacific countries to study the variations and correlations among the housing market among multiple countries. Furthermore, due to international comparisons follow-up studies may include the panel data model for further discussion.

ACKNOWLEDGEMENTS

The authors are grateful for the comments and suggestions received from anonymous referees. However, we are responsible for all remaining errors of this paper.

REFERENCES

[1] Adam. Z. and Fuss.R.(2010) "Macroeconmic determinants of international housing markets", Journal of Housing Economics 19, 38-50.

[2] Andrea B. and Claudio M.(2010) "International house prices and macoreconomic fluctuations" Journal of Banking and Finance. 34:533-545.

[3] Bonnie,B.J.(1998) "The Dynamic Impact of Macroeconomic Aggregates on Housing Prices and Stock of Houses: A National and Regional Analysis," Journal of Real Finance and Economics . 17:179-197.

[4] Case,K.E.(2000)"Real estate an the macroeconomy. Brookings papers on Economic Activity. 20(2):119-162.

[5] Crawford,G, & Fratantoni, M.(2003)"Assessing the forecasting performance of regime-switching ARIMA and GARCH models of housing price," Real Estate Economic. 31:223-243.

[6] Dua,P.,& D.J.Smyth.(1995) " Forecasting US Home Sales in Using BVAR Models and Survey Data on Households' Buying Attitudes for Homes," Journal of Forecasting . 14 : 167-180

[7] Dua,P., S.M. Miller.& D. J. Smyth.(1999) "Using Leading indicator to Forecast US Home Sales in a Bayesian Vector Autoregressive Framework," Journal of Real Finance and Economics. 18(2) : 191-205.

[8] Eddie C.M. & S. Yue.(2006) " Housing Price Bubbles in Hong Kong, Beijing and Shanghai: A Comparative Study," Journal of Real Estate Financial Economics. 33 : 299-327.

[9] Engle, R. F.& Granger, C. W. J.,(1987) "Cointegration and Error Correction: Representation, Estimation and Testing," Econometrica. 51 : 251-76.

[10] Goetzmann, W., Peng,L. and Yen,J.(2009) "The Subprime Crisis and House Price Appreciation," National Bureau of Economic Research working paper .No.15334

[11] Gupta, Rangan; Das, Sonali.(2008) "Spatial Bayesian Methods of Forecasting House Prices in Six Metropolitan Areas of South Africa;" South African Journal of Economics. 76(2) : 298-313.

[12] Hott,C. & Monnin,P.(2008) "Fundamental Real Estate Prices: An Empirical Estimation with International Data," Journal of Real Finance and Economics. 36 : 427-450.

[13] Johansen, S.(1988) "Statistical Analysis of Cointegration Vectors," Journal of Dynamics and Control. 12 : 231-54.

[14] Johansen, S.(1995) "Likelihood-based inference in cointegrated vector autoregressive models," Oxford University Press : 22-34.

[15] Lucca,D,& Trebbi F(2009) "Measuring Central Bank communication: An Automated Approach With Application to FOMC Statement," National Bureau of Economic Research working paper.15367.

[16] Matteo Iacoviello (2005) "House Prices, Borrowing Constrains, and Monetary Policy in the Business Cycle; " The American Economic Review.6 : 739-762.

[17] Muellbauer & Murphy(1997) "Booms and busts in the U.K.," Housing Market Economic Journal. 107：1701-1727.

[18] Quigley, J.M (1999)."Real estate prices and economics cycles". International Real Estate Review. 2(1)：1-20.

[19] Sutton.G.,(2002)."Explaining changes in house prices ". BIS, Quarterly Review. Bank for Internatioanl Settlements. Sep.

[20] Raymond Y. C., & Fischer, D. (2003) "Estimating Natural Vacancy Rates in Office Markets Using a Time-Varying Model",. Journal of Real Estate Literature. 11(1)

[21] Terrones. M., and Otrok. C., (2004) "The global house price boom ",. IMF World Economic Outlook. Sep.

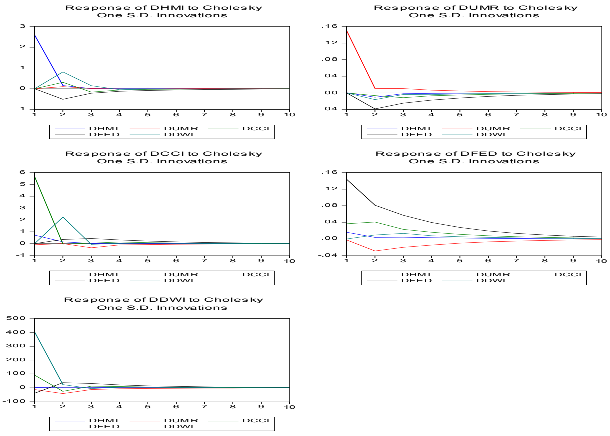

Figure 1

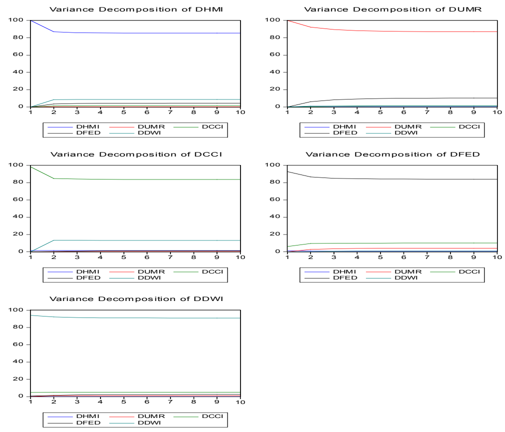

Figure 2