PREDICTING BEAR STOCK MARKET IN THAILAND WITH MACROECONOMIC VARIABLES VIA MARKOV SWITCHING MODEL

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By

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ABSTRACT

This study explores predictability of macroeconomic variables to predict bear stock market in Thailand. We start with Markov-switching model of stock return; then filtered probability of bear stock market to evaluate power of prediction, and finally run the results to in-sample and out-of sample. The conclusion is that all macroeconomic variables together play the best indication for predicting bear stock market. Moreover, set of public debt and inflation rate can be treated as the second most powerful of prediction.

I. INRODUCTION

Many researches focus on Stock market. Some researchers are interested in analysis stock return while some are interested in trend of stock market. The stock market will be called the bear stock market when recession takes place, otherwise bull stock market. The bear stock market displays a low return and high volatility. On the other hand, the bull market shows high returns and small volatility.

Generally, the recession can be predicted before it occurs. Some analysts have already forecasted the movement of decline in economy in many countries, for instance USA, Japan, UK etc. In recent study of Shiu-Sheng Chen (2008), term spread and inflation rate can be indicators to predict the recession in US Stock market. Geoffrey H. Moore (1967) studied the movement of GNP in current and in constant dollars, industrial production, employment, unemployment and personal income to forecast business cycle of USA.

Understandably, knowing the beginning of recession is the most benefit for government, investors or even individuals to decrease the effect of facing recession. In the same way, knowing the time of bear stock market is also useful. Therefore this research Intends to investigate the predictive ability of macroeconomic variables for forecast bear stock market. This study applies Two-state Markov switching model by using monthly data on the return of SET index of Stock exchange of Thailand, Interest rates, inflation rates, unemployment rates, public debt, narrow Money (M1), real effective exchange rate and manufacturing production index from January 1990 to December 2007.

This research provides benefit directly to investors as reference to form market-timing strategy in Thailand Stock Market. Moreover, policy maker can refer to this study to forecast and make plan for Thailand economy.

II.LITERATURE REVIEW

Many researchers have been interested to predict the movement of economy for a long time. To name some, Robert B. Barsky and J. Bradford De Long (1990) set a model for forecasting the growth of future dividend. Bertrand Candelon, Jan Piplack , Stefan Straetmans (2008) measured the synchronization level between stock market ‘‘bulls’’ and ‘‘bears’’to Five Asian stock markets. Ilhan Meric, Mitchell Ratner ,and Gulser Meric , (2008) found that investors gain more benefit in bull market with global diversification than with domestic diversification but this premise cannot applies in bear market. It is implied that bear market provides same benefit to domestic and global investment.

The recession is another topic that influenced most researchers to study characters and its cycle. Seymour E. Harris (1958) suggested that recession is a result of failure of monetary policy while Jamie Peck (2002) provided that US occurrence of recession depends on politic-economic moment.

Focusing on predicting recession, Robert B. Barsky and J.Bradford De Long (1990) analyzed U.S. stock market as bull and bear market in Twentieth Century. Geoffrey H. Moore (1976) provided cycle peak date and calculates the percentage change over the first 3rd, 4th, 5th etc. months following that date. GNP in current and in constant dollars, industrial production, employment, unemployment, personal income, and other series of United State were applied to his study.

To study recession, various models and various variables are applied. Min Qi (2001) focused on economic variables i.e. 4-Interest rate and spread variables, 3 stock price indices, 8 monetary aggregates, 9 individual macro indicators, and 3 indices of leading indicators, by using neural network model to predict US recessions. Fernando Ferna’ndez-Rodrgueza, Simo’n Sosvilla-Riverob, Mara Dolores Garca-Artiles (1999) applied a nearest-neighbour technique to Nikkei 225 Index to forecast the short term forecasting of the future behavior in bear market.

Liliana Gonzaleza, John G. Powellb, Jing Shic,T, Antony Wilsond (2005) identified bull and bear market turning point by using a formal turning point identification procedure with monthly data in two centuries of NYSE stock price index while Dueker Michale (2005) studied the spread, fund rate, GDP growth and CPI inflation to estimate a vector auto regression to improve the modeling of James Stock and Mark Watson (1989) model; then, the Federal Reserve Bank of San Francisco applied this model along with yield curve to predict recession.

Moreover, document from Federal Reserve Board, Washington D.C. Jonathan H. Wright (2006-07), had also studied yield curve to predict recession. He figured out the correlation among growth, recession, and Interest rates and found that the term spreads was a useful leading indicator. Also, Shiu-Sheng Chen (2008) found that the most useful predictors of recessions in the US stock market were term spreads and inflation rates and macroeconomic variables were better predicting bear markets than predicting returns in the stock market.

III.THEORETICAL FRAMEWORK

A Two-state Markov Switching model.

Markov process is a part of stochastic process. Consider a stochastic process { X_t }, where each X_t assumes a value in the space T. The process {X_t} is a Markov process if it has the property that, given the value of X_t , the value of X_h , h>t, do not depend on the value X_s, s< t. In other words, {X_t }is a Markov Process if its conditional distribution function satisfied

$$P(X_h \mid X_s, s \leq t) = P(X_h \mid X_t),\ h>t.$$

Two-State Markov Chain:

Identify the two states as 0 and 1 and assume that the transition probability matrix P is given by

$$P = \begin{pmatrix} p^{00} & 1-p^{11} \\ 1-p^{00} & p^{11} \end{pmatrix}$$

where:

$$P^{00} = P(S_t = 0 \mid S_{t-1} = 0),$$

$$P^{11} = P(S_t = 1 \mid S_{t-1} = 1),$$

S (t) is the state variable that changes through time.

S (t) is determined by Markov chain.

No matter how many states, the two-state Markov chain will focus only state t-1 and t. The outcome of the next state will depend on the current state alone.

For instance: At State t-1 = 0, the probability that state t will be 0 is p^{00} , the probability that state t is 1 will be 1- p^{00} .

On the other hand, at state t-1 = 1, the probability that state t will be 1 is p^{11} ; so that the probability that state t is 0 will be 1- p^{11} .

Markov Switching Model and Maximum likelihood:

Supposed that when the process is in regime 1, the observed variable y_t is drawn from $N(\mu_1, \sigma_1^2)$ distribution and from $N(\mu_2, \sigma_2^2)$ distribution when the process is in regime 2. Therefore, the density of y_t conditional on the random variable S_t taking on the value j is

$$f(y_t \mid S_t = j ; \theta) = \frac{1}{\sqrt{2\pi}\sigma_j} \exp\left(\frac{-(y_t - \mu_j)^2}{2\sigma_j^2}\right) \quad , j = \{0,1\}$$

Where θ is composed of $\mu_1, \mu_2, \sigma_1^2, \sigma_2^2$

S_t is the state variable with transition probability matrix P, Markov switching model is the change in regime by differentiating on factor μ_j, σ_j^2 of S_t and $S_{t-1.}$ Let π_j represents unconditional probability

$$P\{S_t = j ; \theta\} = \pi_j \text{ for } j = \{0,1\}$$

$$p(y_t, S_t = j ; \theta) = \frac{\pi_j}{\sqrt{2\pi}\sigma_j} \exp\left(\frac{-(y_t - \mu_j)^2}{2\sigma_j^2}\right) \quad , j = \{0,1\}$$

The unconditional density of y_t is found by summing possible value for j:

$$f(y_t ; \theta) = \frac{\pi_0}{\sqrt{2\pi}\sigma_0} \exp\left(\frac{-(y_t - \mu_0)^2}{2\sigma_0^2}\right) +$$

$$\frac{\pi_1}{\sqrt{2\pi}\sigma_1} \exp\left(\frac{-(y_t - \mu_1)^2}{2\sigma_1^2}\right) +$$

Thus, the log likelihood for the observed data is

$$L(\theta) = \Sigma^T_{t=1} \log f(y_t ; \theta)$$

The maximum likelihood for estimating θ is calculated by maximizing $L(\theta)$ subject to constraIns that $\pi_0 + \pi_1 = 1$ and $\pi_0 , \pi_1 >= 0$

Supposed that the observations came from regime j, $P(S_t = j \mid y_t ; \theta)$ equal unity and equal zero for the observations that came from other regime. Then the estimate of the mean for regime j is the average value of y_t. Normally, where $P(S_t = j \mid y_t ; \theta)$ is between o and 1 for some observations, the estimated μ_j is a weighted average of all the observations in the sample, where the weighted for observation y_t is proportional to the probability that date t's observation was generated by regime j. Similarly, the estimated σ_j^2 is a weighted average of the squares deviations of y_t from estimated μ_j while estimated π_j is the fraction of observations that appear to have come from regime j. To calculate value of them, an appealing iterative algorithm for finding the maximum likelihood is applied.

$$P\left\{S_t = j \middle| y_t = \theta\right\} = \frac{p(y_t, s_t = j; \theta)}{f(y_t; \theta)} = \frac{\pi_j(y_t, s_t = j; \theta)}{f(y_t; \theta)} \qquad (1)$$

$$\hat{\mu}_j = \frac{\sum_{t=1}^{T} y_t \bullet P\left\{S_t = j \middle| y_t; \hat{\theta}\right\}}{\sum_{t=1}^{T} P\left\{S_t = j \middle| y_t; \theta\right\}} \qquad (2)$$

$$\hat{\sigma}_j^2 = \frac{\sum_{t=1}^{T} (y_t - \hat{\mu}_j)^2 \bullet P\left\{S_t = j \middle| y_t; \hat{\theta}\right\}}{\sum_{t=1}^{T} P\left\{S_t = j \middle| y_t; \hat{\theta}\right\}} \qquad (3)$$

$$\hat{\pi}_j = T^{-1} \sum_{t=1}^{T} P\left\{S_t = j \middle| y_t; \hat{\theta}\right\} \qquad (4)$$

Begin with the value of θ, denoted $\theta^{(0)}$, one could calculate $P\{S_t = j \mid y_t ; \theta^{(0)}\}$ from (1), and replace value of θ with $\theta^{(0)}$ in (2) ,(3), (4) then the value in left side are estimated $\theta^{(1)}$. Next, the $\theta^{(1)}$ can reevaluate $P\{S_t = j \mid y_t ; \theta^{(1)}\}$ and recalculate the value in right side of (2) ,(3), (4). Then the value in left side of them can produce new estimate $\theta^{(2)}$. This cycle will reproduce until the change between $\theta^{(m+1)}$ and $\theta^{(m)}$ is smaller than some specified convergence criteria.

This is a special case of *EM* principle developed by Demster, Laird, and Rubin (1977). It can be concluded that if the iterations reach the point such that $\theta^{(m+1)} = \theta^{(m)}$, algorithm finds the maximum likelihood estimate θ.

Filtered probability:

When the Markov switching model can estimate probability of each state, the filtered probability is the probability at preferred state. Such as the state 0 is preferred, the filtered probability equals to probability at state 0 changes to other state.

$$Q_{0,t} = P(S_t = 1 \mid y^t) ,\qquad \text{when } Q_{0,t} \text{ is the filtered probability at state 0.}$$

Smoothing probability;

The smoothing probability is set to reduce errors estimated from filtered probability. It is calculated from averaging filtered probability in backward. The value obtained from smoothing probability is flatter than filtered probability.

IV.DATA AND METHODOLOGY

MODEL

The processes in this research are the following:

1. The stock market fluctuations are characterized by using parametric approach to identify Bull and Bear stock market.

A two-state Markov-switching model Let r = 100 x Δ p_t , where p_t is the logarithm of the nominal stock price. Therefore, r_t can be Interpreted as stock returns. Consider a simple two-state mean/variance Markov-switching model of stock returns:

$$R_t = \mu_{St} + \epsilon_{t,} , \epsilon_{t,} \sim \text{i.i.d } N(0, \sigma_{st}^2),$$

where μ_{st} and σ^2_{st} are the state-dependent mean and variance of r_t , respectively. The unobserved state variable s_t is a latent dummy variable set at either 0 or 1. Let s_t = 0 indicate the bear market and s_t = 1 the bull market.

A fixed transition probability matrix :

$$P = \begin{pmatrix} p^{00} & 1\text{-}p^{11} \\ 1\text{-}p^{00} & p^{11} \end{pmatrix}$$

where:

$$P^{00} = P(S_t = 0 \mid S_{t-1} = 0),$$

$$P^{11} = P(S_t = 1 \mid S_{t-1} = 1),$$

When Bull and Bear market have been statistically identified, the filtered probabilities of each state is

$$Q_{j,t} = P(S_t = j \mid y^t), \ j = \{0,1\}$$

y^t is information set at time t. So that, $Q_{0,t} = P(S_t = 0 \mid y^t)$ is an estimation for the probability of the bear market.

2.Predictive regression model and out of sample test for Markov switching model.

Refer to the filtered probabilities Q in the model, the next step is to measure the predictability of each macroeconomic variable by setting the predictive regression model as:

$$Q_{0,t+k} = \alpha + \beta x_t + e_t \qquad ; k=1, 3,6,12 \text{ and } 24$$

x_t denotes a macroeconomic variable.

For in-sample test, the model will set $\beta = 0$ to be a null hypothesis of no predictive power of future recessions, and $\beta \neq 0$ otherwise. Therefore, the forecast ability of a macroeconomic variable is measured by β.

For out-of sample test, the objective is also to calculate bear market predictability. The two models are settled as following:

$$\text{Restricted model} : Q_{0,t+k} = \alpha_1 + u_{1,t} \ ,$$

$$\text{Unrestricted model} : Q_{0,t+k} = \alpha_2 + \beta x_t + u_{2,t}$$

A positive out-of sample test means that the predictive ability of the unrestricted model is better than that of the restricted model or it can imply that the model that uses macroeconomic variable has more predictive power by referring to the newly proposed statistic developed by Clark and West (2007). That is MSPE-adj test. It is an approximately normal test to check the correction of result. The model below is formed.

$$\text{MSPE-adj} = \frac{\sqrt{P}}{\sqrt{\hat{V}}} \bar{f}$$

The null hypothesis specified equality between MSPE-adj in restricted and unrestricted model. Otherwise, the unrestricted model has less MSPE-adj than restricted model

Where:

P denotes out-of sample observations.

$\hat{u}^1_{t+k}$ and $\hat{u}^2_{t+k}$ denotes forecasting errors from the restricted and unrestricted model respectively.

$\hat{Q}^1_{0,t+k}$ and $\hat{Q}^2_{0,t+k}$ = forecasting ability from the two models above.

$\bar{f} = P^{-1} \sum_t f_{t+k}$

$$f_{t+k} = (\hat{u}^1_{t+k})^2 - (\hat{u}^2_{t+k})^2 - (\hat{Q}^1_{t+k} - \hat{Q}^2_{t+k})^2$$

$\hat{V}$ = sample variance of $f_{t+k} - \bar{f}$

In this study, there are 7 macroeconomic variables : Public Debt (Debt), Inflation Rate (Inf), Interest Rate (Ir), Unemployment Rate (Unemp), Narrow Money Growth (M1) ,Effective Exchange Rate(REER) and Manufacturing Production Index (MPI).

The first process is to test the goodness-of-fit of those variables in k period. By setting the regression model as:

Restricted model: $Q_{0,t+k} = \alpha_1 + u_{1,t}$;where $Q_{0,t+k}$ denotes filtered probability

Unrestricted model: $Q_{0,t+k} = \alpha_2 + \beta_1 debt_{,t} + u_{2,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_3 + \beta_2 Inf_{,t} + u_{3,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_4 + \beta_3 Ir_{,t} + u_{4,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_5 + \beta_4 Unemp_{,t} + u_{5,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_6 + \beta_5 M1_{,t} + u_{6,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_7 + \beta_6 REER_{,t} + u_{7,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_8 + \beta_7 MPI_{,t} + u_{8,t}$

Unrestricted model: $Q_{0,t+k} = \alpha_9 + \beta_8 debt_{,t} + {}_9 Inf_{,t} + \beta_{10} Ir_{,t} + \beta_{11} Unemp + \beta_{12} M1_{,t} + \beta_{13} MPI_{,t} + \beta_{14} REER_{,t} + u_{9,t}$

The second process is to check the correction of the result from using MSPE-adj of Clark and West (2007) with null hypothesis that value of MSPE-adj between restricted and unrestricted model are equal. The high value of MSPE-adj will show the high predictability of that variable compared with no variable.

Next, considering the last equation of first process to investigate set of variables that have predictability. Thus, each macroeconomic variable will be tested goodness-of-fit with this equation in every k period. Continue this process by grouping variables that have high value of Adjusted R^2 in each k period then test MSPE-adj by changing those unrestricted model in first process (except last equation) to be restricted model and change the last equation of first process to be unrestricted model. Moreover, also test MSPE-adj with the group of macroeconomic variables that already selected from previous step. The high value of MSPE-adj will show the high predictability of that variable compared with all variables.

Once the result shows which variable has the most predictive power compared with equation that has no variable and with all variables. The next question is the return of stock can be estimated from these macroeconomic variables. Therefore, the regression model of testing will be settled:

$r_{t+k} = \alpha + \beta x_t + e_t$, where r_{t+k} is the stock return.

Then, repeat the process above to evaluate goodness-of-fit and MSPE-adj for no variable and all variables respectively.

The last process is to run robustness test by changing filtered probability with smoothing probability. Again, repeat steps of testing goodness-of-fit and MSPE-adj as describe in testing with filtered probability.

DATA

Main purpose of this study is to test predictability of macroeconomic variables to forecast bear stock market in Thailand Stock Market. The analysis is conducted by using monthly data of Thailand Stock and major macroeconomic variables of Thailand during 1990-2007.

The analysis will treat SET index of Stock Exchange of Thailand as a leading indicator since it have been launched 33 years ago, and it was originated from (current market value x 100)/ Base Market Value, meaning that it can represent the movement of stock market of Thailand.

In addition, the independent variables that will be tested in this research are leading predictors of Thailand economy. The first one is Interest rate. Obviously, Interest rate is found in many empirical studies as a main approach hypothesis testing, Min Qi (2001) applied 4 Interest rates as variables to calculate US recession; Martin Younga, Warren Hoganb, and Jonathan Batten (2004) used Interest rate to investigate the effectiveness of Tokyo Stock Exchange (TSE), etc.

The remaining variables are inflation rate, unemployed rate, public debt, narrow money (M1), real effective exchange rate (REER) and manufacturing production index (MPI) that is used as a proxy of GDP. Many countries in the world measure them as Economic indicators. Inflation rate is a measure of inflation, the rate of increase of a price index. Unemployment rate measures an economic performance in each country. Public debt expresses the situation of government. Moreover, The Bank of Thailand employs those variables to announce the status of financial and economic in Thailand.

The source of each variable used in this research is described in table I.

[Table I is here]

V. Empirical Results

1.Estimation results for Markov-Switching model

Refer to quote from the Center for Research in Security Prices " The high-return stable and low-return volatile states in stock returns are conventionally labeled as bull markets and bear market, respectively". Table II. Presents the estimation results for the Markov-Switching model. The regime with higher mean (μ_1 = 0.40) and lower standard deviation (σ_1= 2.65) is assumed to be bull market. The regime with lower mean (μ_0 = -0.59) and higher deviation (σ_0= 5.73) is assumed to be bear market.

The transition probabilities show that the bull market regime persists, on average, for $1/(1-p^{11})$ = 1/(1-0.97) = 38 months, while it is expected that the bear market regime will persist for 1/(1-0.96) = 22 months.

[Table II is here]

2.In-sample results

After obtaining estimates from the Markov-switching model, the filtered probability is computed as graph in Fig.I

[Fig. I is here]

After that, predictive regression is run by setting restricted model and unrestricted as mentioned in model topic.

Adjusted R^2 is used for measuring the goodness-of-fit of those variables. The empirical result, Adjusted R^2 at k=1, k=3, k=6, k=12, k=24, are reported in Table III. Consider the one-variable model, the Adjusted R^2 shows low value or even negative value meaning that they alone have a small power to predict bear stock market in Thailand but when test them together as in last equation, they have the most power of prediction. Since the model of 7 macroeconomic variables seems redundant, more parsimonious model with equal predictive power is the next step to investigate. Therefore, the last six rows are set to discover adjusted R^2 to close to all variables'. No matter 2, 3, 4 or 5 variables, the Adjusted R^2 are relatively greater than 0.5 in 1 to 6 months period and close to 0.5 for 1 and 2 years meaning that the predictive ability will decrease when time is past. However, it cannot be judged which variable have highest power of prediction. Therefore, the out of sample test will be a tool for solving this problem.

[Table III is here]

3.Out-of-sample results

The out-of-sample results are obtained by setting the out of sample observation as last 25% of total observation. The MSPE-adj test will be applied.

Firstly, the restricted model is set as $Q_{0,t+k} = \alpha_1 + u_{0,t}$ and unrestricted models are as following :

1.$Q_{0,t+k} = \alpha_1 + \beta x_{it} + u_{1,t}$, where x_i are macroeconomic variables.

2.$Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_3 Ir + \beta_4 Unemp + \beta_5 M1 + \beta_6 REER + \beta_7 MPI + u_{2,t}$

3. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_4 Unemp + \beta_5 M1 + \beta_6 REER + u_{3,t}$

4. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_4 Unemp + u_{4,t}$

5. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + u_{5,t}$

6. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_5 M1 + \beta_7 MPI + u_{6,t}$

7. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_6 REER + \beta_7 MPI + u_{7,t}$

8. $Q_{0,t+k} = \alpha_1 + \beta_1 debt + \beta_2 Inf + \beta_5 M1 + \beta_6 REER + u_{8,t}$

The positive value of MSPE-adj represents higher value of the error value in restricted model. Meaning that the restricted model has less predictive power than unrestricted model. As the results from Table IV, it is absolutely confirmed that the macroeconomic variables have more predictive ability than no variable.

[Table IV is here]

Beyond knowing that macroeconomic variables have predictability, the next step is to compare predictive power among equation (2) and equation (1) ,(3) through (8) to examine proper variables to have the predictive ability to close the ability of it. The unrestricted model is located as (2) and restricted model are equation (1) ,(3) through (8)

[Table V is here]

Table V shows that many variables have predictive ability close to all variables but if review back on the value of Adjusted R^2 (Table III) and MSPE-adj (Table IV), group of public debt and inflation rate (equation 5) performs the most appropriate variables since they show high value of Adjusted R^2 and has more predictive power than no variable.

4. A comparison with return predictability

The previous topic is testing predictability of macroeconomic variable whether they have power to forecast bear stock market in Thailand or not. As a comparison, testing ability to predict return of stock instead of state of stock is interested since there are a lot of studies trying to forecast the stock return.

To test this, the processes in item2 and 3 will be repeated but the filtered probability is changed to the stock return by setting the regression model as is $r_{t+k} = \alpha + \beta x_t + e_t$, where r_{t+k} is the stock return.

[Table VI is here]

[Table VII is here]

[Table VIII is here]

The results show in Table VI, VII and VIII respectively. Both values of Adjusted R^2 in Table VI and MSPE-adj in table VII and VIII show quite low number and not significant. It can be implied that those macroeconomic variable cannot be used as predictors to forecast return of stock.

4.Robustness

To check the robustness of the empirical results, smoothing probability obtained from Markov-switching model is used to measure predictive power of macroeconomic variables. Fig.I show smoothing probability obtained from Markov-switching model.

[Fig.I is here]

In sample test

The regression model is the same as model in sample test item 2 but it is changed filtered probability to smoothing probability in bear market state.

The Adjusted R^2 are shown in table IX. Similarity, group of every macroeconomic variable show high value in Adjusted R^2.

[Table IX is here]

Out-of-sample test

To repeat process in item 3 but changing filtered probability to smoothing probability. The MSPE-adj values are shown in Table X and Table XI.

[Table X is here]

[Table XI is here]

In Table X, the results show that every macroeconomic variable have predictability when compared to no variable in restricted model

Once considering table XI, every macroeconomic variable still have more predictive power than group of all variables. To examine which variable has most proper to predict bear stock market ,item 2 ,item 3 and item4 will be considered together. The group of public debt and inflation rate still perform the best predictor.

VI.CONCULSION

This paper begins with question whether macroeconomic variables have predictive power to predict bear stock market or not. To test the question, the Markov switching model of stock return is settled. And the macroeconomic variables to be tested are public Debt (Debt), inflation Rate (Inf), Interest Rate (Ir), unemployment Rate (Unemp), narrow Money Growth (M1) ,effective Exchange Rate(REER) and manufacturing production index (MPI).

The filtered probability is a main factor to test goodness-of-fit of predictive regression. The regression is settled as $Q_{0,t+k} = \alpha_1 + \beta x_{it} + u_{1,t}$ when Q denotes filtered probability , x_i denotes macroeconomic variable and k= 1,3,6,12 and 24.

After that, the Adjusted R_2 is examined which variable is appropriate to predict bear stock market but before revision the MSPE-adj must be applied to test equality between having macroeconomic variable and no macroeconomic variable and test between each macroeconomic variable and all variables. The result shows that macroeconomic variable has predictability and group of public debt and inflation act as the most appropriated variable.

With the result from testing above, it brings a question whether macroeconomic variable has predictability to forecast return of stock or not. Therefore, the predictive regression is changed to $r_{0,t+k} = \alpha_1 + \beta x_{it} + u_{1,t}$ when r denotes stock return. Repeat the step of testing goodness-of-fit and MSPE-adj. The result shows that no predictive power in macroeconomic variable to predict stock return.

Final step is to test robustness, the process for estimating adjusted R^2 and MSPE-adj will be repeated but change filtered probability to smoothing probability obtained from Markov switching model. The result can confirm that macroeconomic variable has predictive power when compared to test with no variable. Moreover, when comparing predictive power with group of all variable the set of public debt and inflation still acts as the most appropriated variable.

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TABLE I

Source of data

Variable	Period	Source
SET Index	Jan 1990 - Dec 2007	Stock Exchange of Thailand
Public debt (Debt)	Jan 1990 - Dec 2007	Public Debt Management Office
Inflation rate (Inf)	Jan 1990 - Dec 2007	Office of the National Economic and Social Development Board
Interest rate (Int)	Jan 1990 - Dec 2007	The Bank of Thailand
Unemployed rate (Unemp)	Jan 1990 - Dec 2007	National Statistical Office of Thailand
Narrow money (M1)	Jan 1990 - Dec 2007	The Bank of Thailand
Real Effective Exchange Rate (REER)	Jan 1990 - Dec 2007	The Bank of Thailand
Manufacturing Production Index (MPI)	Jan 1990 - Dec 2007	The Bank of Thailand

TABLE II

Markov-switching models of stock returns

	Markov-switching
μ_0	-0.59
μ_1	0.40
σ_0	5.73
σ_1	2.65
p^{00}	0.96
p^{11}	0.97

Note: The dependent variable is stock returns. The Markov-switching model is $r_t = \mu_{st} + \epsilon_t$, with mean/ variance ($\mu_0$,σ_0^2) in regime 0 and (μ_1 ,σ_1^2) in regime 1. It can be assumed that μ_0 ,σ_0^2 represent the value of mean and variance of bear stock market.

TABLE III

In-sample predictability test results for predicting bear stock market: Markov-switching model.

	Adjusted-R^2				
	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	0.4634	0.4409	0.3910	0.3349	0.1415
Inflation Rate (Inf)	-0.0029	0.0019	0.3910	0.0096	0.0784
Interest Rate (Ir)	0.1063	0.1215	0.1219	0.1203	0.1939
Unemployment Rate (Unemp)	0.2508	0.2179	0.1517	0.0942	0.0227
Narrow Money Growth (M1)	0.1744	0.1755	0.1797	0.1466	0.1064
Effective Exchange Rate (REER)	-0.0040	-0.0005	0.0131	0.0675	0.1473
Manufacturing Production Index (MPI)	0.2185	0.2191	0.2306	0.1983	0.1877
All Variables	0.6091	0.6018	0.5665	0.5538	0.5500
Debt, Inf, Unemp, M1, REER	0.5995	0.5907	0.5664	0.5554	0.4880
Debt, Inf, Unemp	0.5728	0.5597	0.5124	0.4482	0.3500
Debt, Inf	0.5398	0.5365	0.5051	0.4486	0.3530
Debt, Inf, M1, MPI	0.6074	0.6045	0.5693	0.5073	0.4584
Debt, Inf, REER, MPI	0.5843	0.5791	0.5051	0.5552	0.4850
Debt, Inf, M1, REER	0.5929	0.5858	0.5534	0.5557	0.5091

Note: The prediction regression model is $Q_{0,t+k} = \alpha + \beta x_{it} + e_t$, where $Q_{0,t+k}$ is the filtered probability obtained from Markov-switching model.

Result: This table is to test goodness-of-fit of macroeconomic variables and equation. The result shows that the equation that has all macroeconomic variables in one equation has the highest value of Adjusted R^2. Meaning that it is the most appropriate macroeconomic variable to predict bear stock market.

TABLE IV

Out-of Sample predictability test results for predicting bear stock market: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	**4.8700**	**4.7721**	**4.6877**	**4.5682**	**4.0118**
Inflation Rate (Inf)	0.4257	0.5912	0.7451	0.8705	**1.7943**
Interest Rate (Ir)	**4.3495**	**4.2536**	**4.1946**	**4.2740**	**4.6299**
Unemployment Rate (Unemp)	**4.3350**	**3.9629**	**3.8170**	**3.7009**	**3.3167**
Narrow Money Growth (M1)	**4.7833**	**4.7244**	**4.6680**	**4.5232**	**4.3010**
Effective Exchange Rate (REER)	**3.2015**	**3.3330**	**3.6586**	**4.2692**	**4.6237**
Manufacturing Production Index (MPI)	**4.6073**	**4.5706**	**4.5210**	**4.4242**	**4.2394**
All Variables	**6.5860**	**4.7810**	**4.7566**	**4.7619**	**4.4059**
Debt, Inf, Unemp, M1, REER	**4.7651**	**4.7265**	**4.7410**	**4.8011**	**4.5964**
Debt, Inf, Unemp	**4.6872**	**4.5346**	**4.4747**	**4.5325**	**4.2012**
Debt, Inf	**4.6886**	**4.5648**	**4.4620**	**4.5327**	**4.1816**
Debt, Inf, M1, MPI	**4.8513**	**4.7821**	**4.7278**	**4.6981**	**4.4084**
Debt, Inf, REER, MPI	**4.7461**	**4.7241**	**4.7296**	**4.7972**	**4.6439**
Debt, Inf, M1, REER	**4.9185**	**4.8724**	**4.8205**	**4.7091**	**4.5881**

Note: Bold entries represent significance at 10% level (1.282)

Result: This table is to compare predictive power between all macroeconomic parameter above and the equation that has no macroeconomic variable in one equation. The bold numbers represent that those variables have more predictive power than the predictive power of equation that has no macroeconomic variable.

TABLE V

Out-of Sample predictability test results for predicting bear stock market: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	**3.1498**	**3.2313**	**3.8178**	**3.7471**	**4.1025**
Inflation Rate (Inf)	**4.8003**	**4.7114**	**4.6501**	**4.5084**	**3.7949**
Interest Rate (Ir)	**3.9013**	**3.8425**	**3.8956**	**4.1723**	**3.8318**
Unemployment Rate (Unemp)	**2.7346**	**2.7259**	**3.2177**	**3.6577**	**4.1680**
Narrow Money Growth (M1)	**2.2549**	**2.0828**	**2.5101**	**2.6049**	**3.0111**
Effective Exchange Rate (REER)	**4.7428**	**4.5964**	**4.3426**	**4.2425**	**3.9495**
Manufacturing Production Index (MPI	**1.6579**	**1.4969**	**1.6039**	**1.9761**	**2.2302**
Debt, Inf, Unemp, M1, REER	0.3928	0.4023	0.5431	-0.1125	1.0947
Debt, Inf, Unemp	1.2712	**1.7837**	**2.6505**	**2.7016**	**2.6241**
Debt, Inf	**2.2449**	**2.2241**	**2.8893**	**2.7662**	**2.6517**
Debt, Inf, M1, MPI	0.0742	0.8071	**1.8879**	0.7836	1.2605
Debt, Inf, REER, MPI	0.5854	0.4193	**1.4785**	0.6925	1.0352
Debt, Inf, M1, REER	-0.3907	-0.6657	0.3685	1.0909	0.7811

Note: Bold entries represent significance at 10% level (1.282)

. *Result:* This table is to compare predictive power between all macroeconomic parameter above and the equation that has all macroeconomic variables in one equation. The bold numbers represent that those variables have more predictive power than the predictive power of equation that has all macroeconomic variables.

TABLE VI

In-sample predictability test results for predicting bear stock returns.

	Adjusted-R^2				
	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	0.0007	-0.0006	-0.0034	-0.0028	-0.0052
Inflation Rate (Inf)	0.0069	0.0078	-0.0034	0.0001	0.0003
Interest Rate (Ir)	0.0087	0.0050	0.0003	-0.0044	-0.0034
Unemployment Rate (Unemp)	-0.0044	-0.0040	0.0065	-0.0024	-0.0032
Narrow Money Growth (M1)	-0.0038	-0.0043	-0.0030	-0.0049	-0.0049
Effective Exchange Rate (REER)	0.0014	-0.0011	0.0035	0.0058	-0.0027
Manufacturing Production Index (MPI)	-0.0028	-0.0035	-0.0005	-0.0048	-0.0052
All Variables	0.0039	-0.0015	0.0291	0.0293	-0.0185
Debt, Inf, Unemp, M1, REER	0.0118	0.0074	0.0269	0.0121	-0.0159
Debt, Inf, Unemp	0.0152	0.0098	0.0290	0.0027	-0.0063
Debt, Inf	0.0154	0.0144	0.0123	0.0009	-0.0036
Debt, Inf, M1, MPI	0.0074	0.0069	0.0100	-0.0071	-0.0075
Debt, Inf, REER, MPI	0.0134	0.0100	0.0123	0.0156	-0.0101
Debt, Inf, M1, REER	0.0138	0.0044	-0.0022	0.0146	-0.0153

Note: The prediction regression model is $r_{t+k} = \alpha + \beta x_t + e_t$, where r_{t+k} is the stock return.

Result: This table is to test goodness-of-fit of macroeconomic variables and equation. The result shows that no macroeconomic variable has high value of Adjusted R^2. Meaning that all macroeconomic variables cannot use for predicting return of stock.

TABLE VII

Out-of Sample predictability test results for predicting bear stock returns: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	0.6531	0.6210	0.6443	0.3504	0.5632
Inflation Rate (Inf)	0.6370	0.6990	0.6522	0.3460	-0.5749
Interest Rate (Ir)	0.6895	0.5961	0.5506	-0.2647	0.0928
Unemployment Rate (Unemp)	-1.0270	0.5329	-0.3611	-0.4420	-0.2882
Narrow Money Growth (M1)	0.5733	0.5423	0.6816	0.3907	0.3198
Effective Exchange Rate (REER)	0.5519	0.5122	0.4692	0.2462	0.1683
Manufacturing Production Index (MPI	0.5904	0.6383	0.7248	0.4784	0.4075
All Variables	0.5678	0.8901	1.0077	0.3533	-0.5906
Debt, Inf, Unemp, M1, REER	0.4954	0.6576	0.8698	-0.0114	-0.3397
Debt, Inf, Unemp	0.4295	0.7791	0.7380	0.1603	-0.5393
Debt, Inf	0.7775	0.7698	0.7387	0.4277	-0.3695
Debt, Inf, M1, MPI	0.8205	0.8307	0.8438	0.0411	-0.6253
Debt, Inf, REER, MPI	0.6322	0.5873	0.5904	-0.1066	-0.5780
Debt, Inf, M1, REER	0.4938	0.4200	0.2721	-0.0070	-0.1491

Note: Bold entries represent significance at 10% level (1.282)

Result: This table is to compare predictive power between all macroeconomic parameter above and the equation that has no macroeconomic variables in one equation. There are no number shows the significant value. Therefore, the macroeconomic variables have no predictability to forecast return of stock.

TABLE VIII

Out-of Sample predictability test results for predicting bear stock returns: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	0.3612	0.8080	0.9593	0.3031	-0.6076
Inflation Rate (Inf)	0.4120	0.7737	0.8981	0.1167	-0.7025
Interest Rate (Ir)	0.1424	0.9380	0.9841	0.4092	-0.7209
Unemployment Rate (Unemp)	0.7464	0.8511	1.2523	0.5214	-0.3961
Narrow Money Growth (M1)	0.4234	0.8369	0.9374	0.3295	-0.6631
Effective Exchange Rate (REER)	0.3527	0.9103	1.0466	0.4641	-0.7058
Manufacturing Production Index (MPI	0.3815	0.7713	0.9340	0.3105	-0.6210
Debt, Inf, Unemp, M1, REER	0.3608	0.7612	0.7812	0.7137	-0.8020
Debt, Inf, Unemp	0.5753	0.6117	0.8429	0.1793	-0.7515
Debt, Inf	0.1930	0.6176	0.7962	-0.0151	-0.7385
Debt, Inf, M1, MPI	0.1596	0.5067	0.8127	0.2874	0.0456
Debt, Inf, REER, MPI	0.0719	0.9785	0.9258	0.9179	-0.5757
Debt, Inf, M1, REER	0.6892	1.1366	1.1777	0.7182	-0.7385

Note: Bold entries represent significance at 10% level (1.282)

Result: This table is to compare predictive power between all macroeconomic parameter above and the equation that has all macroeconomic variables in one equation. There are no number shows the significant value. Therefore, the macroeconomic variables have no predictability to forecast return of stock.

TABLE IX

In-sample predictability test results for predicting bear stock market using smoothing probability

	Adjusted-R^2				
	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	0.5399	0.5155	0.4780	0.4139	0.1324
Inflation Rate (Inf)	-0.0025	0.0014	0.4780	0.0158	0.1505
Interest Rate (Ir)	0.1046	0.1075	0.1171	0.1320	0.2635
Unemployment Rate (Unemp)	0.1980	0.1654	0.1262	0.0535	0.0049
Narrow Money Growth (M1)	0.1648	0.1574	0.1406	0.1028	0.1030
Effective Exchange Rate (REER)	-0.0011	0.0048	0.0198	0.0616	0.1754
Manufacturing Production Index (MPI)	0.2185	0.2150	0.2007	0.1690	0.1840
All Variables	0.6787	0.6667	0.6535	0.6819	0.6475
Debt, Inf, Unemp, M1, REER	0.6746	0.6668	0.6561	0.6774	0.5958
Debt, Inf, Unemp	0.6372	0.6229	0.5984	0.5658	0.4562
Debt, Inf	0.6303	0.6211	0.5998	0.5634	0.4571
Debt, Inf, M1, MPI	0.6810	0.6639	0.6330	0.5894	0.5376
Debt, Inf, REER, MPI	0.6687	0.6626	0.5998	0.6623	0.5813
Debt, Inf, M1, REER	0.6641	0.6514	0.6421	0.6647	0.6087

Note: The prediction regression model is $Q_{0,t+k} = \alpha + \beta x_t + e_t$, where $Q_{0,t+k}$ is the smoothing probability obtained from Markov-switching model.

Result: This table is to test goodness-of-fit of macroeconomic variables and equation. The result shows that the equation that has all macroeconomic variables in one equation has the highest value of Adjusted R2. Meaning that it is the most appropriate macroeconomic variable to predict bear stock market.

TABLE X

Robustness check: Out-of Sample predictability test results for predicting bear stock markets: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	**5.4675**	**5.3579**	**5.2522**	**5.0644**	**3.7572**
Inflation Rate (Inf)	0.7730	0.9748	1.1474	**1.3564**	**2.3085**
Interest Rate (Ir)	**4.9911**	**4.8863**	**4.7993**	**4.9562**	**5.3299**
Unemployment Rate (Unemp)	**4.5913**	**4.4251**	**4.2655**	**4.1138**	**3.4763**
Narrow Money Growth (M1)	**5.3907**	**5.2763**	**5.1653**	**5.0449**	**4.7702**
Effective Exchange Rate (REER)	**3.7049**	**3.8433**	**4.2456**	**4.9617**	**5.3080**
Manufacturing Production Index (MPI)	**5.1203**	**5.0462**	**4.9703**	**4.8863**	**4.5950**
All Variables	**7.0707**	**5.5113**	**5.5364**	**5.4259**	**4.8507**
Debt, Inf, Unemp, M1, REER	**5.5400**	**5.5001**	**5.5212**	**5.4699**	**5.0900**
Debt, Inf, Unemp	**5.3379**	**5.2358**	**5.1495**	**5.1823**	**4.5238**
Debt, Inf	**5.3377**	**5.2278**	**5.1444**	**5.2434**	**4.6111**
Debt, Inf, M1, MPI	**5.6462**	**5.5313**	**5.4268**	-5.0829	-5.3127
Debt, Inf, REER, MPI	**4.6708**	**5.2874**	**5.5247**	**5.5425**	**5.2979**
Debt, Inf, M1, REER	**5.7056**	**5.6235**	**5.5642**	**5.5705**	**5.4423**

Note: Bold entries represent significance at 10% level (1.282)

Result: This table is to compare predictive power between all macroeconomic parameter above and the equation that has no macroeconomic variables in one equation. The bold numbers represent that those variables have more predictive power than the predictive power of equation that has all variables.

TABLE XI

Robustness check: Out-of Sample predictability test results for predicting bear stock markets: Clark and West (2007)'s MSPE-adj Statistics

	k=1	*k=3*	*k=6*	*k=12*	*k=24*
Public Debt (Debt)	**4.9496**	**4.8448**	**4.6718**	**4.2978**	**4.3904**
Inflation Rate (Inf)	**5.5570**	**5.4800**	**5.4078**	**5.1422**	**3.6766**
Interest Rate (Ir)	**4.7185**	**4.6912**	**4.8321**	**5.0501**	**3.8082**
Unemployment Rate (Unemp)	**3.2692**	**3.4641**	**3.8283**	**4.3659**	**4.6666**
Narrow Money Growth (M1)	**4.4565**	**4.4099**	**4.2415**	**3.9800**	**3.1434**
Effective Exchange Rate (REER)	**5.4187**	**5.2518**	**5.1805**	**5.1713**	**4.0015**
Manufacturing Production Index (MPI)	**3.3044**	**3.1204**	**3.0953**	**3.2187**	**2.8055**
Debt, Inf, Unemp, M1, REER	0.9972	0.6096	1.2263	0.6980	**1.2945**
Debt, Inf, Unemp	**2.5502**	**2.8005**	**3.0615**	**3.0642**	**2.2457**
Debt, Inf	**3.0203**	**3.0145**	**3.0879**	**3.0596**	**2.1890**
Debt, Inf, M1, MPI	**5.4285**	**5.1755**	**4.1495**	**5.2673**	**5.1316**
Debt, Inf, REER, MPI	**5.3935**	**5.1618**	**4.0657**	**4.5623**	**4.0225**
Debt, Inf, M1, REER	**5.4924**	**5.6350**	**5.6253**	**5.6383**	**5.4724**

Note: Bold entries represent significance at 10% level (1.282)

Result: This table is to compare predictive power between all macroeconomic parameter above and the equation that has all macroeconomic variables in one equation. The bold numbers represent that those variables have more predictive power than the predictive power of equation that has all variables.

TABLE XII

The statistic values of macroeconomic variables and SET index

	Public Debt	Inflation rate	Interest rate	Unemployed rate
Max	36.30	8.29	23.37	5.73
Min	11.50	- 0.25	1.25	0.85
Mean	19.38	3.85	6.33	2.85
Median	16.02	4.07	4.98	2.62
Std.deviatior	7.86	2.02	5.04	1.19

	M1	REER	MPI	SET
Max	999,902.00	106.84	193.81	1,682.85
Min	181,952.50	62.46	49.06	214.53
Mean	499,893.09	88.93	100.74	718.03
Median	429,754.10	88.09	84.27	680.67
Std.deviatior	234,913.74	9.53	37.98	336.01

FIGURE I

SET Index, Filtered probability and Smoothing probability