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AN EMPIRICAL STUDY FOR THE RELATIONSHIP OF CHINESE STOCK MARKET AND MACROECONOMIC INDICATORS

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ABSTRACT

This paper discusses the relationship between Shanghai stock index and nine macro economic indicators, namely CPI, fixed asset investment, export, industrial output, M1, M2, domestic loan, short-term interest rate and savings, using cointegration theorem and Granger causality test during the sample period from January 1996 to December 2005. The whole sample period is further divided into two periods to investigate whether such relationship has become stronger over time. The result shows that stock market is strongly correlated with Chinese macro economy in the long run; half the macroeconomic indicators provide explanatory power to stock index in the short run of the whole sample period. However there is no strong evidence shows that such correlation is stronger in period two than period one.

KEYWORDS: Chinese stock market, macroeconomic indicators, cointegration, Granger causality

INTRODUCTION

Time series analysis is one of the heart content of econometrics. A time series is a sequence of data points, measured typically at successive times, spaced at (often uniform) time intervals. Time series analysis focuses on the correlations between observations of different time intervals. Various empirical studies of modern macroeconomics and financial economics are based on time series analysis.

Trygve Haavelmo (1944) introduced the “probability approach” to econometrics, which argued that we can test the validity of economic theories by couching the theoretical model in terms of statistical relationships which can then be tested. Numbers of new models of time series were rapidly developed during 50s-70s in twentieth century. Any time series can be viewed as a realization of a stochastic process, which allows researchers deduce regression model using statistical methods. One important hypothesis is that time series are stationary, that the mean and variance is constant and covariance only depends on the difference between t_1 and t_2, if a time series is not stationary, then it is non-stationary. If a time series is stationary, then it ensures estimators of least squares has uniformly asymptotic normality. But in practical, most macroeconomic and financial time series are non-stationary series. Before the 1980s many economists used linear regressions on (de-trended) those non-stationary time series, empirical studies found out that such approaches ignored two important properties of macroeconomic and financial time series: non-stationary and heteroskedasticity. Adopting properties of stationary time series to non-stationary series would cause serious problems, what Clive Granger (1974) and others showed to be produce spurious correlation.

When dealing with non-stationary time series, for long time economists differenced original series to make them stationary and modeled using differenced series. But models based on differenced series usually lost the meaning of long-run information, which was a real difficulty.

Clive Granger and Robert Engle (1987)'s paper introduced a new concept of "cointegration", that set of combination of non-stationary time series might become stationary, and thus could be adopted statistical methods correctly. Clive Granger also verified that cointegration equation and error correction model could be transformed with each other, which offered a method to investigate long-run and short-run relationship of macroeconomic and financial time series. The concept of cointegration is very useful when modeling with non-stationary time series. If and only if there exist cointegration relationship between non-stationary time series, regression model is meaningful, so cointegration theorem also eliminate the possibility of spurious regression. There are two main methods for testing cointegration, one is developed by Granger and Engle (1987), called EG two-step method, which suits for conditions with two variables; the other one is Johansen's procedure, brings out by Johansen (1988) and Juselius (1990), can be test for cointegration relationship with multiple variables.

Except for cointegration theorem, Clive Granger (1969) developed "Granger causality test" which is a technique for determining whether the history values of one time series are useful in forecasting another. The Granger causality test can be applied only to pairs of variables, and may produce misleading results when the true relationship involves three or more variables. (When, for instance, both of the variables being tested are "caused" by a third, they may have no true relationship with each other, yet give positive results in a Granger test). Granger causality is expected to be test on pairs of stationary time series, but if the two series are cointegrated, there must be Granger causality in at least one direction, as one variable can help forecast the other. (Clive Granger, 1986) Thus Granger causality test can be an auxiliary tool for determining the relationship of cointegrated time series.

However, these tests for cointegration assume the cointegrating vector is constant during the period of study. In reality, it is possible that the long-run relationship between the underlying variables changes (shifts in the cointegrating vector can occur). The reason for this might he technological progress, economic crises, changes in the people's preferences and behavior accordingly, policy or regime alteration, and organizational or institutional developments. This is especially likely to be the case if the sample period is long. To take this issue into account Gregory and Hansen (1996) have introduced tests for cointegration with one unknown structural break and Hatemi-J (2004) has introduced tests for cointegration with two unknown breaks.

The development of cointegration theorem offers an approach to deal with the relationship of massive non-stationary macroeconomic and financial time series. In many developed countries, the market capitalization of stock market has surpassed GNP, which indicates that stock market should play an important role in macro economy. Levine (1997) suggested that stock market is related to the level of economic growth, and countries with higher GDP have more developed stock markets.

In 1986 first Chinese stock exchange was established in Shanghai, Chinese stock market has been exists for over two decades. Till the end of 2007, according to Shanghai Stock Exchange and Shenzhen Stock Exchange, there were 1530 listed companies, with a total market capitalization of US$ 4673 billion (RMB 32710 billion), which is 158% of GNP.

The Shanghai Stock Exchange is a Chinese stock exchange based in the city of Shanghai, built in 1990, with a market capitalization of US$ 3854 billion (RMB 26980 billion), making it the largest in mainland China. Mainland China has a second, smaller stock exchange: the Shenzhen Stock Exchange, located in the city of Shenzhen, has a market capitalization of US$ 819 billion (RMB 5730 billion). Both stock exchanges are non-profit organization directly administered by the China

Securities Regulatory Commission.

There are two types of stocks being issued in the Shanghai and Shenzhen Stock Exchange: A shares and B shares. A shares are priced in the local RMB currency, while B shares are quoted in U.S. dollars. Initially, trading in A shares are restricted to domestic investors only while B shares are available to both domestic (since 2001) and foreign investors. However, after reforms were implemented in December 2002, foreign investors are now allowed (with limitations) to trade in A shares under the Qualified Foreign Institutional Investor (QFII) system, which eventually merge the two types of shares.

1.1. Purpose of the study

The developing Chinese stock market still contains a lot of problems: lack of information exposures; the structure of investors is unbalanced: stock prices is leading by institution investors; individual investors are not rational, for example, according to the study by Zhao Jiamin(2004), the herding behavior significantly exists in both stock market and bond market, Liu Bo et al(2004) discovered that herd effect exists in all Chises stock market, and such effect is stronger when stock index is falling than when it’s rising; and according to Gao Lei and Cao Yongfeng(2006), stock prices not only depend on market but also to some level depend on macroeconomic policies, good news has more effect on bear market and bad news has more effect on bull market; Xiao Lei(2005) investigated the insider trading of Chinese stock market and the it turned out that such behavior is common, especially for good news. Reasons above lead to high uncertainty of stock prices, yet still all kinds of forecasts are delighted by analysts.

Most of the Chinese analysts forecasting stock price are based on the movement of stock market itself, few studies were done on investigating the quantities level of policies or other macroeconomic indicators will affect stock prices. As the market capitalization of stock markets has surpassed GNP in recent years, it gives rise to the question of to what extent will stock markets and macro economy relate to each other. The appearance of cointegration theorem offers an approach to investigate relationship of multiple non-stationary time series with original series, avoid of using differenced series of which long-run information is lost. However, many previous Chinese studies focused on the impact of individual macroeconomic indicator and some published papers failed to use cointegration theorem correctly (Wang Ruize, 2007). This paper discusses the relationship between stock index and nine macroeconomic indicators in order to give a comprehensive view and for further analysis, the whole sample period is divided into two stages to investigate whether such relationship has changed over time. The relationship between stock prices volatility and macroeconomic factors representing the whole economy developing level is always an important issue worthy of studying.

1.2. Hypothesis

Levine (1996) suggested that stock market is positively related to the economic growth and that country with higher GDP also has more developed stock markets. However Harris (1997) found out that the existence of a stock market does not necessarily enhance the economic growth by raiding the marginal productivity of capital. Moreover, in the less developed countries, the level of stock market activity does not offer much incremental explanatory power. And in developed countries, the level of stock market activity does have some impact, but its statistical significance is weak, and its point estimate less than half the value suggested by Atje and Jovanovic (1996) for their whole sample.

At this point gives rise to the doubt that whether the situation is the same in Chinese economy, this paper investigates the relationship between macroeconomic indicators and the first hypothesis is as follows:

H1: There is relationship between macroeconomic indicators and stock market index on the whole period (January, 1996—December, 2005)

In addition, given the fact that the market value of Chinese stock market was approaching GNP and in 2007 surpassed GNP, it is worth studying that if H1 holds, whether such relationship has grown stronger over time, which brings about the second hypothesis of this paper:

H2: The relationship between macroeconomic indicators and stock market index of period 2(July, 2001---December, 2005) is stronger than period 1(June, 1996---June, 2001).

This paper will first examine H1, if H1 holds, than H2 will be examined. If H1 does not hold, there's no need to study H2.

1.3. Literature review

There have been relevant studies about such relationship for the past few years of worldwide.

1.3.1. Literatures outside of China

Demirgüç -Kunt and Levine (1995) collected and compared many different indicators of stock market development using data on 41 countries from 1986 to 1993 and tried to find the links between stock markets, economic development, and corporate financing decisions. In their study, they found out that there are intuitively appealing correlations among indicators. They concluded that countries with well-developed stock markets also have well-developed banks and nonblank financial intermediaries, while countries with weak stock markets tend to have weak banks and financial intermediaries. For example, big markets tend to be less volatile, more liquid, and less concentrated in a few stocks. Internationally integrated markets tend to be less volatile. And institutionally developed markets tend to be large and liquid. The level of stock market development is highly correlated with the development of banks, nonblank financial institutions (finance companies, mutual funds, and brokerage houses), insurance companies, and private pension funds.

Levine and Zervos (1996) empirically evaluated the relationship between stock market development and long-term growth. The data suggested that stock market development is positively associated with economic growth. Moreover, instrumental variables procedures indicated a strong connection between the predetermined component of stock market development and economic growth in the long run. Levine’s study also suggested that countries with higher GDP have more developed stock markets. Atje and Jovanovic (1996), using a similar approach ,also found a significant correlation between economic growth and the value of stock market trading relative to GDP for forth countries over the period 1980-88.

However Harris (1997) showed that this relationship is at best weak. Re-estimating the same model for forty-nine countries over the period 1980-91, but using current investment rather than lagged, and utilizing two-stage least squared, he suggested that the existence of a stock market does not necessarily enhance the economic growth by raiding the marginal productivity of capital. Moreover, in the less developed countries, the level of stock market activity does not offer much incremental explanatory power. And in developed countries, the level of stock market activity does have some impact, but its statistical significance is weak, and its point estimate less than half the value suggested by Atje and Jovanovic (1996) for their whole sample.

Levine and Zerovos (1998) studied the empirical relationship between various measures of stock market development, banking development, and long-run economic growth. The findings suggested that even after controlling for many factors associated with growth, stock market liquidity and banking development are both positively and robustly correlated with contemporaneous and future rates of economic growth, capital accumulation, and productivity growth.

Harris Dellas and Martin K. Hess (2000) investigated how the relative contribution of external factors to stock price movements varies with the degree of financial development. And they found out that financial development makes a country's financial (stock) markets more sensitive to foreign economic shocks.

1.3.2. Literatures within China

Duan Jin et al. (2006) investigated the relationship of money supply and stock market and found out that the stock market influences the structure of M2 but not its gross; M1 has no direct effect on stock market, while M2's effect to stock market is statistically around critical level.

Liu Huangsong and Yang Yi (2003) found out that there's no long-run cointegration between stock prices and M1, but changes in M1 will affect stock price and stock price will affect M0. They also discovered that if the incremented money supply is large than last year, than Shanghai Stock Market Index is likely to rise, vise versa.

Zhang Xiaobing(2007) discovered that stock index has positive relationship with money demand in the long run, while in the short run, asset substitution effect was found.

The empirical study by Junhua Xu, Qiya Li(2002) tried to find the relationship between stock markets, economic development and policy, the results are as follows:

positive correlations was found between economic development, policies and stock prices, the weak effectiveness of stock market to economy development indicates that the stock market is still developing, comparing to post-1996, after 1997, more stock market policies were made, policies will make stock markets volatile, but the volatility is decreasing; the stock market is highly affected by stock market policies.

Wang Kaiguo (1999) and Tan Ruyong (2000) evaluated relationships with different stock market indicators and economy developing. Results were consisted with foreign scholars: in the less developed countries, the level of stock market activity does not offer much incremental explanatory power. Also a lot of previous empirical evidences have confirmed the importance of stock market policies to stock price movements.

1.4. Structure of the paper

This paper is generated as follows: first section gives a introduction of history of relevant econometric methods and a briefly mention of structure of Chinese stock market, as well as purpose and hypothesis of the paper and past studies in and outside of China.; second section explains the monetary transmission mechanism and third section explains methodologies applied in this paper; forth section is the empirical analysis of data and discussion of the results; and finally fifth section provides a conclusion as well as contributions of the paper.

2. THEORY OF MONETARY TRANSMISSION MECHANISM

In a modern financial system, monetary measures are transmitted into the real economy through several channels, mainly interest rate channel; other asset price channel and credit channel

2.1. The Interest Rate Channel

The interest rate channel of the monetary transmission mechanism is based on the Keynesian LM-IS model which assumes that an expansive monetary policy leads to an increase in the supply of money, which causes real interest rates on the money market to fall (at a constant level of demand for money). This development creates conditions for changes in medium- term interest rates on loans, with an effect on the level of investment as well as aggregate expenditure in the economy.

Apart from creating conditions for a change in interest levels in the economy, the fall in short- and medium-term interest rates arouses the desire of economic entities to consume or save, and is based on the fact that lower interest rates increase the current value of goods as well as demand for such goods. Hence, expenditures on interest rate sensitive goods are affected by the marginal costs of new loans. Deposit rates also adjust gradually to the lending rates. These changes in interest rates affect the income and cash flow of debtors and creditors. Thus, interest rate variations induced by monetary policy may lead to changes in the cash flows of creditors and debtors, and consequently to changes in their consumption and investment expenditures. In this case, we may speak of an "income channel", which covers the effect of changes in net interest payments in the individual sectors when applied to aggregate expenditure in the economy. This mechanism can be expressed as follows:

M ↑ => r ↓ => I ↑ => E ↑ => Y ↑ (1)

where a expansionary money policy leads to higher money supply (M ↑) and a decease of interest rate (r ↓), in turn rise in the investment (I ↑) and output (E ↑), thus the income will increase (Y ↑).

2.2. Other Asset Price Channels

2.2.1. Tobin's q theory

Tobin's q-theory (Tobin, 1969) provides an important mechanism for how movements in stock prices can affect the economy. Tobin's q is defined as the market value of firms divided by the replacement cost of capital. If q is high, the market price of firms is high relative to the replacement cost of capital, and new plant and equipment capital is cheap relative to the market value of firms. Companies can then issue stock and get a high price for it relative to the cost of the facilities and equipment they are buying. Investment spending will rise because firms can now buy a lot of new investment goods with only a small issue of stock.

The crux of the Tobin q-model is that a link exists between stock prices and investment spending. Expansionary monetary policy which lowers interest rates makes bonds less attractive relative to stocks and results in increased demand for stocks that bids up their price. Combining this with the fact that higher stock prices will lead to higher investment spending, leads to the following transmission mechanism of monetary policy which can be described by the following schematic:

M ↑ => Ps ↑ => q ↑ => I ↑ => Y ↑ (2)

where M ↑ indicates expansionary monetary policy, leading to a rise in stock prices

(Ps ↑), which raises q (q ↑), which raised investment (I ↑), thereby leading to an increase in aggregate demand and a rise in output (Y ↑).

Another way of getting to this same mechanism is by recognizing that firms not only finance investment through bonds but by issuing equities (common stock). When stock prices rise, it now becomes cheaper for firms to finance their investment because each share that is issued produces more funds. Thus a rise in stock prices leads to increased investment spending. Therefore, an alternative description of this mechanism is that expansionary monetary policy (M ↑) which raises stock prices (Ps ↑) lowers the cost of capital (c↓) and so causes investment and output to rise (I ↑, Y ↑). In other words:

$$M \uparrow \Rightarrow Ps \uparrow \Rightarrow c \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \qquad (3)$$

2.2.2. Wealth effect

Modigliani’s (1963) life cycle model states that consumption is determined by the lifetime resources of consumers. An important component of consumers’ determined lifetime resources is their financial wealth, a major component of which is common stocks. Thus expansionary monetary policy raises stock prices as well as the value of household wealth, thereby increasing the lifetime resources of consumers, which causes consumption to rise. This produces the following transmission mechanism:

$$M \uparrow \Rightarrow Ps \uparrow \Rightarrow W \uparrow \Rightarrow C \uparrow \Rightarrow Y \uparrow \qquad (4)$$

where W ↑ and C ↑ indicate household wealth and consumption rises.

2.2.3. Exchange rate channel

With the growing internationalization of economies throughout the world and the advent of flexible exchange rates, more attention has been paid to how monetary policy affects exchange rates, which in turn affect net export and aggregate output. Clearly this channel does not operate if a country has a fixed exchange rate, and the more open an economy is, the stronger is this channel.

Expansionary monetary policy affects exchange rates because when it leads to a fall in domestic interest rates, deposits denominated in domestic currency become less attractive relative to deposits denominated in foreign currencies. As a result, the value of domestic deposits relative to other currency deposits falls, and the exchange rate depreciates (E ↓). The lower value of the domestic currency makes domestic goods cheaper than foreign goods, thereby causing a rise in net exports (NX ↑) and hence in aggregate spending (Y ↑). The schematic for the monetary transmission mechanism that operates though the exchange rate is:

$$M \uparrow \Rightarrow E \downarrow \Rightarrow NX \uparrow \Rightarrow Y \uparrow \quad (5)$$

2.3. Credit channel

2.3.1. Bank lending channel

The bank lending channel assumes that internal funds, bank loans and other sources of financing are imperfect substitutes for firms. The key point is that monetary policy besides shifting the supply of deposits also shifts the supply of bank loans. This mechanism can be expressed as follows:

$$M \downarrow \Rightarrow \text{bank reserves} \downarrow \Rightarrow \text{bank loans} \Rightarrow I \downarrow \Rightarrow Y \downarrow \quad (6)$$

2.3.2. Balance-sheet channel

The presence of asymmetric information problems in credit markets provides another transmission mechanism for monetary policy that operates through stock prices. This mechanism is often referred to as the “credit view”, and it works through the effect of stock prices on firm’s balance sheets so it is also referred to as the balance-sheet channel. (Bernanke and Gertler, 1995)

The lower the net worth of business firms, the more severe is the adverse selection and moral hazard problems in lending to these firms. Lower net worth means that there is effectively less collateral for the loans made to a firm and so potential losses from adverse selection are higher. A decline in net worth, which increases the severity of the adverse selection problem, thus leads to decreased lending to finance investment spending. The lower net worth of business firms also increase the moral hazard problem because it means that owners of firms have a lower equity stake, giving them greater incentives to engage in risky investment projects. Since taking on riskier investment projects makes it more likely that lenders will not be paid back, a decrease in net worth leads to a decrease in lending and hence in investment spending.

Monetary policy can affect firms’ balance sheets and aggregate spending through the following mechanism. Expansionary monetary policy (M ↑) which causes a rise in stock prices (Ps ↑) along lines described earlier, raises the new worth of firms (NW ↑), which reduces adverse selection and moral hazard problems, and so leads to higher lending (L ↑). Higher lending then leads to higher investment spending (I↑) and aggregate spending (Y ↑). Equivalently this balance-sheet channel of monetary transmission can be expressed as following schematic

$$M \uparrow \Rightarrow Ps \uparrow \Rightarrow NW \uparrow \Rightarrow L \uparrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \qquad (7)$$

3. METHODOLOGY

3.1. Unit root test

A unit root test tests whether a time series is non-stationary using an autoregressive model. While most econometric techniques are designed for analyzing stationary series, the common occurrence of models containing stock variables and their first derivatives indicates that the problems associated with dealing with models which include variables of different orders of integration, are important. The most commonly used test for unit root is the Augmented Dickey-Fuller test, while the other is the Phillips-Perron test. Both two tests take the existence of a unit root as the null hypothesis. This article applies both two methods, below is the introduction of ADF test and Phillips-Perron test respectively.

3.1.1. Augmented Dickey-Fuller Test

The testing procedure for the ADF test is the same as for the Dickey-Fuller test but it is applied to the model

$$\Delta y_t = a + g y_{t-i} + b_0 tr + \sum_{i=1}^{p} b_i \Delta y_{t-i} + e_t \tag{8}$$

$$\Delta y_t = a + g y_{t-i} + \sum_{i=1}^{p} b_i \Delta y_{t-i} + e_t \tag{9}$$

$$\Delta y_t = g y_{t-i} + \sum_{i=1}^{p} b_i \Delta y_{t-i} + e_t \tag{10}$$

where a is a constant, b_0 is the coefficient on a time trend and p the lag order of the autoregressive process. Equation (8) denotes to the model contains both intercept and trend, (9) denotes to model only with intercept, while (10) denotes to model without intercept and trend. Imposing the constraints $a = 0$ and $b_0 = 0$ corresponds to modeling a random walk and using the constraint $a = 0$ corresponds to modeling a random walk without a drift.

By including lags of the order p the ADF formulation allows for higher-order autoregressive processes. This means that the lag length p has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannon Quinn criterion.

The unit root test is then carried out under the null hypothesis against the alternative hypothesis of $g < 1$. Once a value for the test statistic

$$DF_t = \frac{(\hat{g} - 1)}{SE(\hat{g})} \tag{11}$$

is computed it can be compared to the relevant critical value for the Dickey-Fuller Test. If the test statistic is less than the critical value then the null hypothesis of $g = 1$ is rejected and no unit root is present.

3.1.2. Phillips-Perron Test

Phillips and Perron (1988) propose an alternative (nonparametric) method of controlling for serial correlation when testing for a unit root. The PP method estimates the non-augmented DF test equation, and modifies the t-ratio of the a coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic.

The PP test is based on the statistic:

$$\tilde{t}_a = t_a \left(\frac{g_0}{f_0} \right)^{1/2} - \frac{T(f_0 - g_0)(se(\tilde{a}))}{2 f_0^{1/2} s} \quad (12)$$

Where $\tilde{a}$ is the estimate, and $\tilde{t}_a$ is the t-ratio of a, $se(\tilde{a})$ is coefficient standard error, and s is the standard error of the test regression. In addition, g_0 is a consistent estimate of the error variance in the above equation (calculated as $(T-k)s^2/T$, where k is the number of regressors. The remaining term, f_0, is an estimator of the residual spectrum at frequency zero. The asymptotic distribution of the PP modified t-ratio is the same of that of the ADF statistic.

3.2. Vector auto regression (VAR)

Vector auto regression (VAR) is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. Based on this feature, Christopher Sims (1980) advocates the use of VAR models as a theory-free method to estimate economic relationships, thus being an alternative to the "incredible identification restrictions" in structural models.

Let $Y_t = (y_{1t}, y_{2t}, ..., y_{nt})'$ denote a $(n \times 1)$ vector of time series variables. The basic *p*-lag vector autoregressive (VAR (*p*)) model has the form

$$Y_t = c + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + ... + \Pi_p Y_{t-p} + e_t, t = 1, ..., T \quad (13)$$

Where Π_i are $(n \times n)$ coefficient matrixes and e_t is an $(n \times 1)$ zero mean white noise vector process (serially uncorrelated or independent) with time invariant covariance matrix Σ. For example, a bivariate VAR (2) model equation can be written as

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} + \begin{pmatrix} p^{1}_{11} & p^{1}_{22} \\ p^{1}_{21} & p^{2}_{22} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} p^{2}_{11} & p^{2}_{12} \\ p^{2}_{21} & p^{2}_{22} \end{pmatrix} \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \end{pmatrix}. \tag{14}$$

In lag operator notation, the VAR (p) is written as

$$\Pi(L) = I_n - \Pi_1 L - \ldots - \Pi_p L^p. \tag{15}$$

The VAR (p) is stationary if the roots of set $(I_n - \Pi_1 z - \ldots - \Pi_p z^p) = 0$ lie outside the complex unit circle (have modulus greater than one), or, equivalently, if the eigenvalues of the companion matrix

$$F = \begin{pmatrix} \Pi_1 & \Pi_2 & \cdots & \Pi_n \\ I_n & 0 & \cdots & 0 \\ 0 & \ddots & 0 & \vdots \\ 0 & 0 & I_n & 0 \end{pmatrix} \tag{16}$$

have modulus less than one.

Five methods are usually applied for selecting lag length for VAR models:

1. Using F statistics

$$F = \frac{(SSE_r - SSE_u)/m}{SSE_u/(T-k)} \sim F_{(m, T-k)} \tag{17}$$

2. Using LR(likelihood ratio) statistics

$$LR = -2(\log L_{(k)} - \log L_{(k+1)}) \sim c^{2}(N^{2}) \tag{18}$$

3. Using Akaike information criterion (AIC)

$$AIC = -2\left(\frac{\log L}{T}\right) + \frac{2k}{T} \tag{19}$$

4. Using Bayesian information criterion (BIC)

$$BIC = -2\left(\frac{\log L}{T}\right) + \frac{k \log T}{T} \tag{20}$$

5. Using Hannan- Quinn information criterion (HQ)

$$HQ = -2\frac{\log L}{T} + 2k\frac{Ln(LnT)}{T} \tag{21}$$

3.3. Cointegration test

Before testing the cointegration, the integrated order of the series has to be ascertained. If a time series obtain stationary through ***d*** time's difference, then the series is said to be integrated of order *d,* denoted by $I(d)$. Notice that the basic concept of (weak) stationary of time series means that its mean value and variance must be constant so long as it has finite second moment, and all covariance are functions only of the time lag.

Let $X_t = (X_{1t}, X_{2t}, ..., X_{kt})$, with $X_{it} \sim I(d)$. Then X_t is cointegrated of order (d,b), if there exists a vector $a_t = (a_1, a_2, ..., a_n)$ such that $Z_t = aX_t' \sim I(b)$, where $b > 0$, a is cointegration vector. Particularly, X_t is cointegrated of order $(1,1)$ when $d = b = 1$.

The cointegration test model is that suppose $X_t = (y_t, X_{1t}, X_{2t}, ..., X_{kt})$ is a vector composed of $k+1$ time series integrated of order *d*. If there exists cointegration within X_t, then the equation holds,

$$y_t = a_0 + aX_t + m_t \qquad (22)$$

There are two methods for testing the cointegration: E-G two step method and Johansen's procedure.

3.3.1. E-G two step method

In the test procedure, that whether the error term is stationary can be considered to judge a cointegration relationship, in other words, if two time series, properly scaled, can move and turn, but slowly, in similar but not identical fashions, but the distance between them can be stationary (Clive W.J. Granger, 2004). If for two time series x_t and y_t there exists

$$y_t = ax_t + u_t, \qquad (23)$$

if the error terms u_t turn out to be stationary, then there exists cointegration relationship. And the existence of cointegration relationship between two non-stationary time series integrated with the same order implies a long-term equilibrium relationship.

3.3.2. Johansen's cointegration test

For testing the cointegration of more multiple time series of the same order of difference, Johansen (1988) and Juselius (1990) developed a method using Vector Autoregressive Model, which is well known as Johansen's Test or JJ Test.

According to Johansen's derivation, a basis of sp(β) is found as the empirical canonical variates of X_{t-k-1} on ΔX_t adjusted for lagged differences and a constant term m. The adjustment is made by running auxiliary regressions of ΔX_t and X_{t-k-1} on the lagged differences and a constant m :

$$\Delta X_t = \sum_{i=1}^{k} a_i \Delta X_{t-i} + m + R_{0t} \tag{24}$$

$$X_{t-k-1} = \sum_{i=1}^{k} b_i \Delta X_{t-i} + m + R_{kt} \tag{25}$$

Taking the moment and cross-moment matrices of the estimated residuals R_{0t} and R_{kt}, denoted by S_{00}, S_{kk}, and S_{0k}, the required basis of sp(β) is given by the eigenvectors corresponding to the r largest eigenvalues of $S'_{0k} S_{00}^{-1} S_{0k}$ in the metric of S_{kk}. The a matrix corresponding to the estimated b is given by $-S_{0k} b$. Finally, the remaining Γ_i can be estimated from the regression:

$$\Delta X_t + ab' X_{t-k-1} = \sum_{i=1}^{k} \Gamma_i \Delta X_{t-i} + m + e_t \tag{26}$$

a denotes to adjustment coefficient matrix and b denotes to cointegration vector matrix. The number of cointegrating vectors r is determined by a likelihood-ratio test of the null hypothesis of “at most r cointegrating vectors”. The maximized likelihood values of the unconstrained model and of the model with “at most r cointegrating vectors” are given by:

$$L_{\max}^{-2/T} = |S_{00}|(1-t_1)...(1-t_r)...(1-t_p) \tag{27}$$

$$L_{\max}^{-2/T}(H_0) = |S_{00}|(1-t_1)...(1-t_r) \tag{28}$$

where $t_1 \geq ... \geq t_p$ are the eigenvalues of $S'_{0k} S^{-1} S_{0k}$ in the metric of S_{kk}. The square roots of these eigenvalues are called the canonical correlation coefficients, which are a generalization of the conventional multiple correlation coefficient. Their values do not tend to one as sample size increases. Take, for example, $\{X_t\}$to be a one-dimensional white noise process and set k equal to one, the asymptotic eigenvalue is then 1/3.

The log-likelihood ratio test statistic then becomes

$$-2\log Q = -T\sum_{i=r+1}^{p}\log(1-t_i) \qquad (29)$$

The asymptotic distribution of (26) is complicated but tractable.

As with the Dickey-Fuller test, the distribution of the test statistic under the null hypothesis depends on the maintained assumption about m. Suppose $m \neq 0$, then m lies either entirely in the space generated by the a vectors (i.e. $a^{\perp}{}' m \neq 0$), in which case there is no drift in the $\{X_t\}$ process, because the cointegrating vector annihilates the drift; or m cannot be represented by the a vectors alone (i.e. $a^{\perp}{}' m \neq 0$), giving rise to a drift in the $\{X_t\}$ process. The method is easily adapted for testing the joint hypothesis of $-\Gamma_{k+1}$, $-\Gamma_{k+1} = ab'$ and $a^{\perp}{}' m \neq 0$. Johansen and Juselius (1989) provide selected fractiles for all three cases.

Holding the dimension of the cointegrating space fixed, consider testing the null hypothesis $b = Hf$ with H being a given $p \times s$ matrix with $s \geq r$ and with f being a corresponding $s \times r$ weighting matrix. The maximum-likelihood estimator of the cointegrating space under the null hypothesis is found as the empirical canonical variates of $H'X_{t-k-1}$ with respect to ΔX_t adjusted for lagged differences and the constant term. The maximized likelihood under this restriction is then given by:

$$L_{\max}^{-2/T}(H_0 : b = Hf) = |S_{00}|(1-s_1)\ldots(1-s_r) \tag{30}$$

where $s_1 \geq \ldots \geq s_r$ are the r largest eigenvalues of $H'S'_{0k}S_{00}^{-1}S_{0k}H$ in the metric of $H'S_{kk}H$. This yields the log likelihood ratio test statistic:

$$-2\log Q = T\sum_{i=1}^{r} \ln\left[(1-s_i)/(1-t_i)\right] \tag{31}$$

This test statistic is distributed as a chi-square with $r(p-s)$ degrees of freedom.

Likewise, it is possible to test the null hypothesis that the space spanned by the columns of a given $p \times m(1 < m < r)$ matrix K, sp(K), is contained in sp(b). Let F be the orthogonal complement of K, such that $F = K^{\perp}$ and $b = (k, F\Phi)$ with F and Φ being $p \times (p-m)$ and $(p-m)\times(r-m)$ matrices. The maximum-likelihood estimator of the cointegrating space under the above hypothesis is again found by computing the canonical variates of X_{t-k-1}, but now projected onto the orthogonal space of sp(K), i.e. sp(F), with respect to ΔX_t adjusted for lagged differences and the constant term. Furthermore let P denote the projection operator onto the space $(R'_{kt}K)^{\perp}$, i.e. $P = \left[I - R'_{kt}K(K'S_{kk}K)^{-1}K'R_{kt}\right]$. The maximized likelihood under this restriction is then given by:

$$L_{\max}^{-2/T}(H_0 : b = (K, F\Phi)) = |R_{0t}PR'_{0t}|(1-d_1)\ldots(1-d_{r-m}) \tag{32}$$

where $d_1 \geq ... \geq d_{r-m}$ are the $r-m$ largest eigenvalues of

$$F'(R_{kt}PR'_{0t})(R_{0t}PR'_{0t})^{-1}(R_{0t}PR'_{kt})F \tag{33}$$

in the metric of $F'(R_{kt}PR'_{kt})F$. The log-likelihood ratio statistic is then just T times the difference between the log of (32) and the log of (28). It is distributed as a chi-square with $m(p-m)$ degrees of freedom.

3.4. Error correction model (ECM)

Error Correction Model is an equivalent form of cointegration, in which the change of one of the series is explained in terms of the lag of the difference between the series, possibly after scaling, and lags of the differences of each series. The other series will be represented by a similar dynamic equation. Data generated by such a model are sure to be cointegrated. The error-correction model has been particularly important in making the idea of cointegration practically useful. It was invented by the well known econometrician Dennis Sargan, who took some famous equations from the theory of economic growth and made them stochastic (Clive W.J. Granger, 2004).

If there exists cointegration within $Xt = (y_t, X_{1t}, X_{2t}, ..., X_{kt})$, take (1,1) regression model for example, that

$$y_t = b_0 + b_1 X_t + b_2 y_{t-1} + b_3 X_{t-1} + e_t \tag{34}$$

By transposition we get

$$\Delta y_t = b_0 + b_1 \Delta X_t + (b_2 - 1)(y_{t-1} - (b_1 + b_3) X_{t-1} / (1 - b_2)) + e_t \qquad (35)$$

The model we get is just VECM, and we can also present it as below

$$\Delta y_t = b_0 + b_1 \Delta X_t + gECM_{t-1} + e_t \qquad (36)$$

where error correction term $ECM_{t-1} = y_{t-1} - (b_1 + b_3) X_{t-1} / (1 - b_2)$.

The Vector Error Correction Model reveals how the short-term volatility of y_t, that is, Δy_t is settled. And error correction term ECM_{t-1} reflects the long-term equilibrium relationship between y_t and X_t, where $(b_1 + b_3)/(1 - b_2)$ is cointegration coefficient. We use the Vector Error Correction Model to estimate the long-term and short-term relationship between macroeconomic factors.

3.5. Granger-causality test

Grange-causality test is adopted in order to demonstrate causality between economic factors, and this test approach can show the direction and intensity of the causality. A times series X is said to Granger-cause Y if it can be shown, usually through a series of F-tests on lagged values of X (and with lagged values of Y also known), that those X values provide statistically significant information about future values of Y.

Grange-causality can be described as that if the prediction error derived from the prediction for *Y* in terms of the history of *X* and *Y* is less than that in terms of the history of *Y* itself, then the causality exists between *X* and *Y*, and we say that *X* Granger-cause *Y*, i.e.

$$d^2\left(Y_t \mid Y_{t-k}, k>0\right) > d^2\left(Y_t \mid Y_{t-k}, X_{t-k}, k>0\right) \tag{37}$$

denoted by $X \rightarrow Y$.

4. EMPIRICAL TEST AND RESULT

4.1. Data description

The paper analyses a set of monthly data over the whole sample period from Jan.1996 to Dec.2005, for further analysis of whether the relationship between stock index and macroeconomic indicators is changing over time, the whole period is divided into 2 stages:

Period 1: from January 1996 to December 2000

Period 2: from January 2001 to December 2005.

The macroeconomic time series are denoted as follows:

SHA: Shanghai Stock Exchange (SSE) Index, average price of daily close price is adopted for each month. The reason of choosing Shanghai Stock Exchange Index instead of Shenzhen or HS Index (an index with 300 A shares from both Shanghai and Shenzhen Stock Index) is because SSE is the biggest stock exchange in mainland China and it can fully represent the Chinese Stock Market and HS index starts as late as 2005.

IP: Industrial Production, an economic report that measures changes in output for the industrial sector of the economy. The industrial sector includes manufacturing, mining, and utilities.

M1: M0 +demand deposits, which are checking accounts. M0 is a measure of the money supply which combines any liquid or cash assets held within a central bank and the amount of physical currency circulating in the economy, which is the most liquid measure of the money supply. M1 is used as a measurement for economists trying to quantify the amount of money in circulation. The M1 is a very liquid measure of the money supply, as it contains cash and assets that can quickly be converted to currency.

M2: M1 + all time-related deposits, savings deposits, and non-institutional money-market funds. M2 is a broader classification of money than M1.

FAI: Fixed Asset Investment. The amount of investment into fixed assets, normally include items such as land and buildings, motor vehicles, furniture, office equipment, computers, fixtures and fittings, and plant and machinery.

EX: Export, is any good or commodity, transported from one country to another country in a legitimate fashion, typically for use in trade.

S: Savings, the amount left over when the cost of a person's consumer expenditure is subtracted from the amount of disposable income that he or she earns in a given period of time.

CPI: Consumer Price Index is an index number measuring the average price of consumer goods and services purchased by households. It is one of several price indices calculated by national statistical agencies. The percent change in the CPI is a measure of inflation.

LOAN: Domestic Loan, which price with local currency, and borrowers are local investors Loans can come from parties, corporations, financial institutions and governments.

Rs: Short-term Loan Interest, the monthly effective rate paid (or received, if you are a creditor) on borrowed money. Interest rates are generally determined by the market, but government intervention – usually by a central bank – may strongly influence short-term interest rates, and is used as the main tool of monetary policy.

The use of monthly data brings up the problem of seasonality, such as series of export, industrial production, and fixed asset investment. Moving average method is applied to smooth original data and all the series are changed into logarithm form to facilitate analysis. Graphs of original and adjusted time series can be found in Appendix I. This paper adopts Eviews 5.0 in analyzing time series.

4.2. Test for whole sample period

4.2.1. Unit root test

Since the cointegration relationship only exists between series integrated at same order, so that unit root test will be applied to indentify the integrated order of each time series.

Lag length is important in unit root test, usually we choose the lag length when Akaike's Information Criterion (AIC) or Bayesian Information Criterion (BIC) is the lowest. In order to increase the accuracy of the result, both Augmented Dickey- Fuller Test and Phillip- Perron Test is adopted, as well as AIC and BIC. Result is decided according to outcomes of the three methods. The general rule of deciding whether a series is stationary is to compare the result of AIC and BIC, if the outcomes don't consist, then PP-test is applied. Eviews automatically decide the maximum lag length, which is 13 in this case

Before testing, whether a series contain intercept or trend should be selected. The procedure is to first examine the line graph of each series, if there is a apparent drift and mean value is distinct from zero, than both trend and intercept are included; if there is no apparent trend and mean value is not zero, than only intercept is included; if the mean value is very close to zero, than neither intercept nor trend is included. The significance of the result is also considered when deciding which type to use.

Table 1 Result of unit root test for whole sample period.

Time series	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary
LNCPI	(c,t,0)	-2.185877	-4.036983	-3.448021	no
D(LNCPI)	(-,-,0)	-9.343578	-2.584707	-1.943563	Stationary***
LNEXSA	(c,t,2)	-1.113528	-4.038365	-3.448681	no
D(LNEXSA)	(c,-,1)	-11.78193	-3.487046	-2.88629	Stationary***
LNFAISA	(c,t,12)	-0.624708	-4.046072	-3.452358	no
D(LNFAISA)	(c,-,11)	-4.503046	-3.492523	-2.888669	Stationary***
LNIPSA	(c,t,3)	-0.167468	-4.039075	-3.44902	no
D(LNIPSA)	(c,-,0)	-15.18426	-3.486551	-2.886074	Stationary***
LNLOAN	(c,t,0)	-1.867286	-4.036983	-3.448021	no
D(LNLOAN)	(c,-,0)	-8.327205	-3.486551	-2.886074	Stationary***
LNM1	(c,t,12)	-2.970419	-4.046072	-3.452358	no
D(LNM1)	(c,-,11)	-2.863716	-3.492523	-2.888669	Stationary*
LNM2	(c,t,0)	-3.861893	-4.036983	-3.448021	no
D(LNM2)	(c,-,1)	-9.507428	-3.487046	-2.88629	Stationary***
LNRs	(c,t,0)	-1.19527	-4.036983	-3.448021	no
D(LNRs)	(c,-,0)	-11.41673	-3.486551	-2.886074	Stationary***
LNS	(c,t,12)	-2.532969	-4.046072	-3.452358	no
D(LNS)	(c,-,0)	-9.045196	-3.486551	-2.886074	Stationary***
LNSHA	(c,t,0)	-2.60352	-4.036983	-3.448021	no
D(LNSHA)	(-,-,0)	-10.5484	-2.584707	-1.943563	Stationary***

*** denotes to significant at 1% level
** denotes to significant at 5% level
* denotes to significant at 10% level

Table 1 shows the final result of unit root test, the result of using AIC, BIC and PP test respectively can be found in Appendix II. This final result is actually the same with the one using BIC, which indicates that BIC fits better for these financial series. Thus in later unit root test for period 1 and period 2, BIC is adopted to decide lag length of ADF test.

In addition, table 1 shows that all series, namely Shanghai stock index, industrial production, M1, M2, fixed asset investment, export, save of residents, CPI, domestic loan and short-term interest rate, are integrated at order 1.

4.2.2. Cointegration Test and ECM

Because all series are I (1) series, we can test the cointegration relationship between them. Firstly the lag length should be decided, table 2 below shows the result of VAR lag length test of unrestricted VAR model.

Table 2 VAR lag length test.

Endogenous variables: LNCPI LNEX LNFAI LNIP LNLOAN LNM1 LNM2 LNRS LNS LNSHA
Exogenous variables: C   Sample: 1996M01 2005M12   Included observations: 112

Lag	LogL	LR	FPE	AIC	SC	HQ
0	1642.328	NA	1.04e-25	-29.14872	-28.90600	-29.05024
1	2823.996	2131.221	4.27e-34*	-48.46421	-45.79426*	-47.38092*
2	2908.150	136.7501*	5.89e-34	-48.18124	-43.08406	-46.11315
3	2978.802	102.1931	1.10e-33	-47.65717	-40.13276	-44.60428
4	3063.455	107.3284	1.79e-33	-47.38312	-37.43148	-43.34543
5	3172.742	119.0447	2.18e-33	-47.54896	-35.17008	-42.52646
6	3305.777	121.1572	2.20e-33	-48.13888	-33.33277	-42.13157
7	3466.898	117.9637	1.93e-33	-49.23033	-31.99699	-42.23821
8	3661.234	107.5788	1.67e-33	-50.91490*	-31.25432	-42.93798

* indicates lag order selected by the criterion

The maximum lag is chosen automatically by Eviews, which is 8. The result shows that LR value chooses lag 2, AIC chooses lag 8, while FPE, BIC and HQ select lag 1. Since LR value of lag 1 is 2131.221, which is much larger than normal value, as a compromise, lag 2 is used in the following analysis.

Both trend and intercept are included in the cointegration equation when doing cointegration rank test, the purpose is to exclude excess information in the cointegration equation. In equation (38) below we can find that t-value for trend term is 5.01014, which is significant and indicates that trend should be including in the cointegration equation.

Table 3 Trace test of cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.446449	328.8030	273.1889	0.0000
At most 1 *	0.430401	259.6091	228.2979	0.0007
At most 2 *	0.349824	193.7590	187.4701	0.0229
At most 3	0.262990	143.3891	150.5585	0.1181
At most 4	0.242300	107.6861	117.7082	0.1810
At most 5	0.215142	75.22245	88.80380	0.3166
At most 6	0.176815	46.87895	63.87610	0.5587
At most 7	0.112477	24.11369	42.91525	0.8319
At most 8	0.058907	10.15320	25.87211	0.9183
At most 9	0.025729	3.049711	12.51798	0.8706

* denotes rejection of the hypothesis at the 0.05 level

Table 4 Max-Eigen test of cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.446449	69.19391	68.81206	0.0460
At most 1 *	0.430401	65.85017	62.75215	0.0244
At most 2	0.349824	50.36985	56.70519	0.1865
At most 3	0.262990	35.70298	50.59985	0.6686
At most 4	0.242300	32.46368	44.49720	0.5264
At most 5	0.215142	28.34350	38.33101	0.4318
At most 6	0.176815	22.76527	32.11832	0.4354
At most 7	0.112477	13.96048	25.82321	0.7259
At most 8	0.058907	7.103493	19.38704	0.8936
At most 9	0.025729	3.049711	12.51798	0.8706

* denotes rejection of the hypothesis at the 0.05 level

As we can see, in table 3, trace test rejects the null hypothesis that there are at most 2 cointegration equations at 5% level, indicates that there are 3 cointegration equations, while in table 4, Max-Eigenvalue test indicates that there're 2 cointegration equations at 0.05 level, both serves the fact that *LNSHA* is cointegrated with other macroeconomic indicator series.

The normalized cointegrating equation derived by Johansen's cointegration test is as follows, with t-value in the square brackets:

$$\begin{aligned} LNSHA = {} & 6.409769LNCPI - 4.522023LNEX - 1.537853LNFAI + \\ & [-2.82425] \quad [5.09069] \quad [4.11294] \\ & 3.365752LNIP - 6.494231LNLOAN + 14.61629LNM1 - \\ & [-3.18241] \quad [2.82200] \quad [-4.84875] \\ & 1.449614LNM2 - 1.077334LNRs + 9.755161LNS - 0.158458Trend \\ & [0.33371] \quad [1.44918] \quad [-2.64248] \quad [5.01014] \\ & - 169.9460 \end{aligned} \tag{38}$$

According to the t-table (see Appendix III), under the degree of freedom of 100, the critical value is 1.984 at 5%. Since the t-value of *LNM2* in equation (38) is 0.33371, which means that *LNM2* may not be necessarily needed in this cointegration equation. Imposing a restriction on *LNM2* that its coefficient equals to zero, the result can be found in table 5 below. The probability of Chi-square value is 0.805669, which means that we can safely take *LNM2* out of cointegration equation (38).

Table 5

Cointegration Restrictions:	
B(1,8)=0	
Convergence achieved after 68 iterations.	
Not all cointegrating vectors are identified	
LR test for binding restrictions (rank = 1):	
Chi-square(1)	0.060531
Probability	0.805659

Thus I derive the following cointegration equation excluding LNM2, with t-value in the square brackets:

$$
\begin{aligned}
LNSHA = {} & 4.545495LNCPI - 4.024612LNEX - 1.229079LNFAI + \\
& [-2.24403] \qquad [5.04109] \qquad [3.64423] \\
& 3.326451LNIP - 5.187504LNLOAN + 12.82431\,LNM1 \;- \\
& [-3.52234] \qquad [2.57660] \qquad [-6.69473] \\
& 1.304889LNRs + 6.635298LNS - 0.145615Trend - 145.5764 \\
& [2.00727] \qquad [-2.36202] \qquad [5.43342]
\end{aligned} \tag{39}
$$

Now the equation looks fine since all t-values are greater than significant value of 5%, and residual test does not imply much significant correlations. This cointegration equation indicates a long-run equilibrium relationship between *LNSHA* and other financial series.

Theoretically when economy is in prosperity, there is a rising money supply, along with a rising investment in capital market, inflation usually takes place and *CPI* goes up, enterprises make more profit and stock market becomes attractive, leading to higher stock prices. If the economy is overheat, inflation keeps rising, the government tends to take tight fiscal policies to restrain total demand, for example, lift short-term interest rate, deposit reserve ratio, rediscount ratio or issue treasury bonds, as a consequence, money supply is about to decrease, borrowing money becomes more expensive, people tends to take money away from stock market and invest in risk free assets, save of residents than rises, which puts a downward pressure to the stock market.

The relationships of what cointegration equation (39) reveals do not all agree with economic theory. According to the equation, in the long run, *LNSHA* is positively related to *LNCPI*, *LNIP*, *LNM1*, *LNS*, and negatively related to *LNEX*, *LNFAI*, *LNLOAN*, and *LNRs*. It is easy to understand that since in the sample period Chinese economy was booming, increasing money supply and growth in industrial output could simulate stock market, and it is reasonable that CPI and stock market moved in the same direction because appearance of inflation, people were earning more so more money were saved; investors could either invest in fixed asset or put money in stock market, and a decreasing interest rate encouraged investment; a growing domestic loan not leading to an increase stock market means that investors didn't put money into the stock market, but into real estate or for other purpose, which is the case since bear market took place from 2001 to 2005.

Equation (39) can be further transformed into error correction model below, with t-value in brackets:

$$\begin{aligned}
\Delta LNSHA_t = & -0.122001\,ECM_{t-1} + 0.042659\,\Delta LNSHA_{t-1} + 0.104580\,\Delta LNSHA_{t-2} \\
& \quad [-3.80208] \qquad [0.44049] \qquad [1.08205] \\
& -0.165175\,\Delta LNCPI_{t-1} - 1.366011\,\Delta LNCPI_{t-2} + 0.333005\,\Delta LNEX_{t-1} \\
& \quad [-0.12590] \qquad [-1.10581] \qquad [2.42190] \\
& + 0.068187\,\Delta LNEX_{t-2} + 0.14394\,\Delta LNFAI_{t-1} + 0.019434\,\Delta LNFAI_{t-2} \\
& \quad [0.57831] \qquad [2.41690] \qquad [0.36856] \\
& - 0.354523\,\Delta LNIP_{t-1} - 0.200184\,\Delta LNIP_{t-2} + 0.160953\,\Delta LNLOAN_{t-1} \\
& \quad [-1.63428] \qquad [-1.13139] \qquad [0.18787] \\
& - 0.753766\,\Delta LNLOAN_{t-2} - 1.235203\,\Delta LNM1_{t-1} - 0.118303\,\Delta LNM1_{t-2} \\
& \quad [-0.91507] \qquad [-2.59523] \qquad [-0.32024] \\
& - 0.513274\,\Delta LNRs_{t-1} - 0.441971\,\Delta LNRs_{t-2} - 2.085710\,\Delta LNS_{t-1} \\
& \quad [-2.08269] \qquad [-1.75315] \qquad [-2.21283] \\
& + 0.575914\,\Delta LNS_{t-2} + 0.038015 \\
& \quad [0.59348] \qquad [1.72239]
\end{aligned} \qquad (40)$$

Error correction model (ECM) is a short term model, in which the coefficient of error correction term ECM_{t-1} will indicates the relationship with long-run equilibrium equation, difference terms indicates the effect of each dependent variables on specified lags. We can find in (40) that ECM_{t-1}, $\Delta LNEX_{t-1}$, $\Delta LNFAI_{t-1}$, $\Delta LNM1_{t-1}$,

$\Delta LNRs_{t-1}$ and ΔLNS_{t-1} have t-values greater than 2, which means these series are statistical significantly related to $\Delta LNSHA_t$. Because the coefficient of ECM_{t-1} is -0.122001, that $\Delta LNSHA_t$ is negatively related to ECM_{t-1}, so in the long run, $\Delta LNSHA_t$ is going to rise because it should converge to the long-run equilibrium mood. Aside for the effect of long-run term, $\Delta LNSHA_t$ is also positively affected by $\Delta LNEX_{t-1}$, $\Delta LNFAI_{t-1}$ and negatively affected by $\Delta LNM1_{t-1}$, $\Delta LNRs_{t-1}$ and ΔLNS_{t-1}. We can find that all significant variables are of lag 1, which means that $\Delta LNSHA_t$ responds to past values of 1 lag. Interestingly, in the long-run equilibrium equation (39) *LNSHA* is positively related to *LNCPI, LNIP, LNM1, LNS*, and negatively related to *LNEX, LNFAI*, *LNLOAN*, and *LNRs*, which is right the opposite in the case of ECM, indicating the appearance of time lag.

4.2.3. Granger causality test

According to the properties of cointegration that if x_t and y_t are I (1) and cointegrated, there must be Granger causality in at least one direction, as one variable can help forecast the other. (C.W.J.Granger, 1986)

Since all the macroeconomic and financial time series are cointegrated, we can test the Granger causality between those series. Table 6 below shows the null hypothesis and result while table 7 indicates other significant result of Granger causality test within 10 lag lengths:

Table 6 Granger causality test of the whole period.

Granger Causality Test(Jan.1996-Dec.2005)	Obs. 118	Lags 2
Null Hypothesis	F-Statistic	Probability
LNSHA does not Granger Cause LNCPI	0.39945	0.67163
LNCPI does not Granger Cause LNSHA	0.21678	0.80544
LNSHA does not Granger Cause LNEX	0.13357	0.8751
LNEX does not Granger Cause LNSHA	1.4803	0.23195
LNSHA does not Granger Cause LNFAI	0.23024	0.79472
LNFAI does not Granger Cause LNSHA	2.53644	0.08365*
LNSHA does not Granger Cause LNIP	0.24372	0.78412
LNIP does not Granger Cause LNSHA	2.02359	0.13694
LNSHA does not Granger Cause LNLOAN	0.85043	0.42995
LNLOAN does not Granger Cause LNSHA	1.75018	0.17842
LNSHA does not Granger Cause LNM1	0.70311	0.4972
LNM1 does not Granger Cause LNSHA	3.64465	0.02925**
LNSHA does not Granger Cause LNM2	2.98742	0.05442**
LNM2 does not Granger Cause LNSHA	1.17483	0.31262
LNSHA does not Granger Cause LNRS	1.66131	0.19449
LNRS does not Granger Cause LNSHA	0.30041	0.74111
LNSHA does not Granger Cause LNS	4.51232	0.01302**
LN does not Granger Cause LNSHA	0.95275	0.38876

*** denotes to significant at 1%level

** denotes to significant at 5% level

* denotes to significant at 10% level

Table 7 More on Granger causality test.

Null Hypothesis	lag	F-Statistic	Probability
LNSHA does not Granger Cause LNEX	3	2.54143	0.06005*
LNSHA does not Granger Cause LNM2	3	3.26901	0.02402**
LNSHA does not Granger Cause LNIP	4	2.06249	0.09082*
LNCPI does not Granger Cause LNSHA	7	2.67146	0.01422**
LNIP does not Granger Cause LNSHA	8	2.43001	0.01956**

*** denotes to significant at 1%level

** denotes to significant at 5% level

* denotes to significant at 10% level

Table 6 indicates that in the whole sample period, under the assumption of lag 2, the null hypothesis of $LNM1$ does not Granger cause *LNSHA* and *LNSHA* does not Granger cause *LNS* is strongly rejected, and the null hypothesis of *LNFAI* does not Granger cause *LNSHA* and *LNSHA* does not Granger cause *LNRs* are rejected at 10%

level. This result is consist with the outcome of previous test of error correction model that $\Delta LNEX_{t-1}$, $\Delta LNFAI_{t-1}$, $\Delta LNM1_{t-1}$, $\Delta LNRs_{t-1}$ and ΔLNS_{t-1} have are significantly related with $\Delta LNSHA_t$. Combining result of ECM and Granger causality test, we can draw the conclusion that in short terms, that is, within about 2 months, fixed asset investment and M1 have significant impact on stock prices; the performance of stock market will significantly affect saving of residence; since *Rs* is under control of central bank, and can be a tool of monetary policy, *LNRs* Granger cause *LNSHA* reveals that stock market is sensitive to policies. Table 7 reveals that *LNSHA* Granger cause *LNEX* and $LNM2$ of 3 lags, and Granger cause *LNIP* in 4 lag length, rejection of *LNCPI* and *LNIP* does not Granger cause *LNSHA* at lag 7 and 8 indicates the there is time lag in market response.

Generally, of the whole sample period, cointegration test suggest pretty strong relationship of stock index and macroeconomic time series in the long-run equilibrium equation (39); ECM (40) indicates that there are short-run correlations, five out of nine macroeconomic series are significantly related to stock index of one lag; Granger causality test showed that there are to some extent related, and time lag is discovered. Summing up, we can safely accept the hypothesis that there are relationships between stock index and macroeconomic indicators in the whole period, and continue to test for H2 of whether such relationship is changing over time.

4.3. Test for period 1

4.3.1. Unit root test

In the previous testing for unit root of whole sample period, BIC, AIC and Phillips-Perron test were both adopted, generally BIC outstand AIC and PP test, thus I chose BIC as a benchmark for testing unit root of period 1 and period 2.

Table 8 below shows that at period 1, *LNFAI* is trend stationary at order 0; $LNM1$ and $LNM2$ are stationary at 10% level, which is somehow a dilemma of whether or not stationary. Thus I tried Akaike's Information Criterion and the outcome P value is 0.1546 and 0.2723 respectively, which suggests that $LNM1$ and $LNM2$ are non-stationary at order 0, and after first difference, the two series become stationary. Base on table 8, *LNCPI*, *LNEX*, *LNIP*, *LNLOAN*, $LNM1$, $LNM2$, *LNRs*, *LNS* and *LNSHA* are stationary at order 1, thus are all I (1) series, and we can discuss the cointegration relationship between those series.

Table 8 Test for unit root of period 1.

Period 1 (Jan.1996 - Dec.2000)	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary
LNCPI	(c,t,0)	0.264845	-4.121303	-3.487845	no
D(LNCPI)	(c,-,0)	-5.955866	-3.548208	-2.912631	Stationary***
LNEX	(c,t,1)	-1.869286	-4.124265	-3.489228	no
D(LNEX)	(c,-,0)	-12.60848	-3.548208	-2.912631	Stationary***
LNFAI	(c,t,0)	-6.340933	-4.121303	-3.487845	Stationary***
LNIP	(c,t,1)	-1.745614	-4.124265	-3.489228	no
D(LNIP)	(c,-,0)	-10.88214	-3.548208	-2.912631	Stationary***
LNLOAN	(c,t,0)	-0.597164	-4.121303	-3.487845	no
D(LNLOAN)	(c,t,0)	-5.24164	-3.548208	-2.912631	Stationary***
LNM1	(c,t,1)	-3.698384	-4.124265	-3.489228	no
D(LNM1)	(c,t,1)	-7.294718	-3.550396	-2.913549	Stationary***
LNM2	(c,t,0)	-3.209312	-4.121303	-3.487845	no
D(LNM2)	(c,t,0)	-7.487237	-3.548208	-2.912631	Stationary***
LNRs	(c,t,0)	-1.430704	-4.121303	-3.487845	no
D(LNRs)	(c,-,0)	-8.509086	-3.548208	-2.912631	Stationary***
LNS	(c,t,0)	-2.34415	-4.121303	-3.487845	no
D(LNS)	(c,-,0)	-6.287993	-3.548208	-2.912631	Stationary***
LNSHA	(c,t,0)	-2.831493	-4.121303	-3.487845	no
D(LNSHA)	(c,-,0)	-7.594635	-3.548208	-2.912631	Stationary***

*** denotes to significant at 1%level

** denotes to significant at 5% level

* denotes to significant at 10% level

4.3.2. Cointegration test and ECM

Before test for cointegration, we set up an unrestricted VAR model and find out the possible lag length, result is shown below:

Table 9 Lag length test of unrestricted VAR for period 1.

Endogenous variables: LNSHA LNCPI LNEX LNIP LNLOAN LNM1 LNM2 LNRS LNS
Exogenous variables: C Sample: 1996M01 2000M12 Included observations: 56

Lag	LogL	LR	FPE	AIC	SC	HQ
0	941.7663	NA	2.75E-26	-33.31308	-32.98758	-33.18689
1	1392.224	740.0377	5.31e-32*	-46.508	-43.25297*	-45.24603*
2	1473.877	107.8981*	6.44E-32	-46.53131	-40.34675	-44.13357
3	1544.439	70.56225	1.77E-31	-46.15853	-37.04445	-42.62502
4	1668.427	84.13476	1.73E-31	-47.69382*	-35.65021	-43.02454

* indicates lag order selected by the criterion

We can see that in table 9 below that LR criterion suggests to take lag 2, while FPE, SC and HQ select lag 1 and AIC choose lag 4. Since LR value for lag 1 is as large as 740.0377, it is not safe enough to take lag 1, as a compromise lag length 2 is chosen for further analysis. Result of rank test can be found in the following table 10 and table 11.

Table 10 Trace test for cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.675431	270.9718	228.2979	0.0001
At most 1 *	0.569741	206.8321	187.4701	0.0035
At most 2 *	0.510396	158.7602	150.5585	0.0158
At most 3 *	0.445852	118.0531	117.7082	0.0475
At most 4	0.369618	84.40470	88.80380	0.0996
At most 5	0.293601	58.10323	63.87610	0.1390
At most 6	0.246728	38.29146	42.91525	0.1344
At most 7	0.198956	22.14167	25.87211	0.1360
At most 8	0.153471	9.496846	12.51798	0.1519

* denotes rejection of the hypothesis at the 0.05 level

Table 11 Maximum Eigenvalue test for cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.675431	64.13974	62.75215	0.0365
At most 1	0.569741	48.07193	56.70519	0.2774
At most 2	0.510396	40.70701	50.59985	0.3604
At most 3	0.445852	33.64845	44.49720	0.4481
At most 4	0.369618	26.30147	38.33101	0.5772
At most 5	0.293601	19.81177	32.11832	0.6669
At most 6	0.246728	16.14978	25.82321	0.5314
At most 7	0.198956	12.64483	19.38704	0.3575
At most 8	0.153471	9.496846	12.51798	0.1519

* denotes rejection of the hypothesis at the 0.05 level

As we can see, trace test suggests that there are 4 cointegration equations and maximum Eigenvalue suggests that there is 1. And the normalized cointegration equation for period 1 is cited below, with t-value in brackets:

$$LNSHA = 11.84268LNCPI - 0.398805LNEX + 3.414677LNIP +$$

$$[-4.36289] \quad [0.84791] \quad [-4.99195]$$

$$8.809076LNLOAN - 5.332556LNM1 + 14.97443LNM2 -$$

$$[-4.95941] \quad [2.46191] \quad [-3.63263]$$

$$1.731726LNRs - 7.847230LNS - 0.143624Trend - 196.7398$$

$$[3.20242] \quad [2.90569] \quad [5.80223] \qquad (41)$$

Equation (41) shows that except for *LNEX*, all other financial indicators are significantly related to *LNSHA* in the long-run equilibrium. Equation (41) can be further transformed into ECM:

$$\Delta LNSHA_t = -0.264591\,ECM_{t-1} - 0.120975\,\Delta LNSHA_{t-1} + 0.035486\,\Delta LNSHA_{t-2}$$
$$[-2.57732] \quad [-0.70592] \quad [0.21192]$$
$$+0.651102\,\Delta LNCPI_{t-1} - 2.650091\,\Delta LNCPI_{t-2} + 0.183476\,\Delta LNEX_{t-1}$$
$$[0.23675] \quad [-0.95783] \quad [0.71813]$$
$$+ 0.003220\,\Delta LNEX_{t-2} - 0.674883\,\Delta LNS_{t-1} + 0.053336\,\Delta LNS_{t-2}$$
$$[0.01423] \quad [-0.38979] \quad [0.02867]$$
$$- 0.965650\,\Delta LNIP_{t-1} - 0.423658\,\Delta LNIP_{t-2} - 1.802502\,\Delta LNLOAN_{t-1}$$
$$[-1.87789] \quad [-1.06520] \quad [-1.19852]$$
$$- 1.637397\,\Delta LNLOAN_{t-2} - 1.185920\,\Delta LNM1_{t-1} + 0.070607\,\Delta LNM1_{t-2}$$
$$[-0.80997] \quad [-1.06629] \quad [0.06469]$$
$$+ 0.406860\,\Delta LNM2_{t-1} - 2.318789\,\Delta LNM2_{t-2} + 0.075559\,\Delta LNRs_{t-1}$$
$$[0.11014] \quad [-0.69478] \quad [0.20036]$$
$$- 0.121394\,\Delta LNRs_{t-2} + 0.114163$$
$$[-0.32219] \quad [1.80993] \qquad (42)$$

It is clearly that we can't find many significant relationships in equation (42), most of the absolute value of t-values are less than 2. But still, ECM_{t-1} has a t-value of -2.57732 and $\Delta LNIP_{t-1}$ is -1.87789, which is close to the critical value. It indicates that long-run equilibrium does impact present value of stock prices and in short-run, stock prices is also negatively influenced by one lag of *LNIP*.

4.3.3. Granger causality test

Table 12 below shows the result of Granger causality test of period 1. We can find that with 2 lags, among all economic indicators *LNEX*, *LNIP*, $LNM1$ and $LNM2$ will Granger cause *LNSHA*; *LNSHA* will Granger cause *LNEX*, $LNM1$, $LNM2$ and *LNS*. In previous error correction model, we've already found that $\Delta LNIP_{t-1}$ offers significant explanatory power to $\Delta LNSHA_t$, which agrees with the result of Granger causality test.

Table 12 Granger causality test for period 1.

Granger Causality Test(Jan.1996-Dec.2000)	Obs. 58	Lags 2
Null Hypothesis	F-Statistic	Probability
LNSHA does not Granger Cause LNCPI	0.36548	0.6956
LNCPI does not Granger Cause LNSHA	0.08261	0.92083
LNSHA does not Granger Cause LNFAI	0.64789	0.52724
LNFAI does not Granger Cause LNSHA	0.94304	0.39588
LNSHA does not Granger Cause LNEX	2.50945	0.09093*
LNEX does not Granger Cause LNSHA	3.21503	0.0481**
LNSHA does not Granger Cause LNIP	1.50123	0.23218
LNIP does not Granger Cause LNSHA	3.17106	0.05003**
LNSHA does not Granger Cause LNLOAN	1.36319	0.26467
LNLOAN does not Granger Cause LNSHA	1.50683	0.23095
LNSHA does not Granger Cause LNM2	2.72483	0.07475*
LNM2 does not Granger Cause LNSHA	3.39669	0.04093**
LNSHA does not Granger Cause LNM1	4.63029	0.01402**
LNM1 does not Granger Cause LNSHA	4.32654	0.01818**
LNSHA does not Granger Cause LNRS	0.83234	0.44064
LNRS does not Granger Cause LNSHA	1.10838	0.33762
LNSHA does not Granger Cause LNS	2.96338	0.06026*
LNS does not Granger Cause LNSHA	2.15704	0.12571

*** denotes to significant at 1%level

** denotes to significant at 5%level

* denotes to significant at 10% level

4.4. Test for period 2

4.4.1. Unit root test

Table 13 shows the result of ADF unit root test using BIC of period 2. It is shown that *LNEX*, *LNFAI*, and $LNM1$ are trend stationary, while *LNCPI*, *LNIP*, *LNLOAN*, $LNM2$, *LNRs*, *LNS* and *LNSHA* are integrated at order 1, which means that we can further test the cointegration relationship between those I(1) series.

Table 13 Unit root test for period 2.

Period 2 (Jan.2001-Dec.2005)	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary
LNCPI	(c,t,0)	-1.875228	-4.121303	-3.487845	no
D(LNCPI)	(-,-,0)	-7.096628	-2.605442	-1.946549	Stationary***
LNEX	(c,t,0)	-4.369633	-4.121303	-3.487845	Stationary***
LNFAI	(c,t,0)	-5.77357	-4.121303	-3.487845	Stationary***
LNIP	(c,t,0)	-2.978566	-4.121303	-3.487845	no
D(LNIP)	(c,-,1)	-8.838144	-3.550396	-2.913549	Stationary***
LNLOAN	(c,t,0)	-0.124127	-4.121303	-3.487845	no
D(LNLOAN)	(c,-,0)	-6.751689	-3.548208	-2.912631	Stationary***
LNM1	(c,t,0)	-4.092559	-4.121303	-3.487845	Stationary**
LNM2	(c,t,0)	-3.093589	-4.121303	-3.487845	no
D(LNM2)	(c,-,1)	-7.753604	-3.550396	-2.913549	Stationary***
LNRs	(c,t,0)	-1.405053	-4.121303	-3.487845	no
D(LNRs)	(-,-,0)	-7.549834	-2.605442	-1.946549	Stationary***
LNS	(c,t,0)	-3.213675	-4.124265	-3.489228	no
D(LNS)	(c,-,0)	-6.277567	-3.548208	-2.912631	Stationary***
LNSHA	(c,t,0)	-2.70951	-4.121303	-3.487845	no
D(LNSHA)	(c,-,0)	-8.127155	-3.548208	-2.912631	Stationary***

*** denotes to significant at 1%level

** denotes to significant at 5%level

* denotes to significant at 10% level

4.4.2. Cointegration test and ECM

Result of lag length test for unrestricted VAR model is displayed in Table 14 below.

Table 14 Lag lengthe test for unrestricted VAR model.

Endogenous variables: LNSHA LNCPI LNIP LNLOAN LNM2 LNRS LNS

Exogenous variables: C   Sample: 2001M01 2005M12   Included observations: 55

Lag	LogL	LR	FPE	AIC	SC	HQ
0	771.7653	NA	1.97E-21	-27.80965	-27.55417	-27.71085
1	1194.994	723.3372	2.46e-27*	-41.41798	-39.37415*	-40.62761*
2	1229.035	49.51374	4.62E-27	-40.87401	-37.04182	-39.39207
3	1289.133	72.11771*	3.89E-27	-41.27757	-35.65704	-39.10407
4	1329.728	38.38051	8.67E-27	-40.97193	-33.56304	-38.10685
5	1423.403	64.72103	4.52E-27	-42.59648*	-33.39924	-39.03983

* indicates lag order selected by the criterion

It is shown that FPE, SC and HQ pick lag 1, LR select lag 3 and AIC choose lag 5. Since LR value for lag one is as large as 723.3372, it is better to choose lag 3 instead of lag 1.

Taking lag length of 3, we can move on to see whether the series are cointegrated. According to table 15 and table 16 below, trace test indicates that there're four cointegration equations at 5% level, and maximum Eigenvalue test suggests that there are two cointegration equation, so we can move on to further analysis.

Table 15 Trace test for cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.639589	199.6359	150.5585	0.0000
At most 1 *	0.562827	142.4874	117.7082	0.0006
At most 2 *	0.399052	96.15145	88.80380	0.0133
At most 3 *	0.365421	67.63358	63.87610	0.0234
At most 4	0.298961	42.16513	42.91525	0.0593
At most 5	0.253242	22.27439	25.87211	0.1315
At most 6	0.100344	5.921586	12.51798	0.4703

* denotes rejection of the hypothesis at the 0.05 level

Table 16 Maximum Eigenvalue test for cointegration rank.

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.639589	57.14853	50.59985	0.0092
At most 1 *	0.562827	46.33592	44.49720	0.0312
At most 2	0.399052	28.51786	38.33101	0.4200
At most 3	0.365421	25.46845	32.11832	0.2599
At most 4	0.298961	19.89074	25.82321	0.2494
At most 5	0.253242	16.35280	19.38704	0.1308
At most 6	0.100344	5.921586	12.51798	0.4703

* denotes rejection of the hypothesis at the 0.05 level

The normalized cointegration equation is expressed as follows, with t-value in the brackets:

$$LNSHA = 6.486444 LNCPI + 0.759815 LNIP - 1.016655 LNLOAN$$
$$[-5.15305] \quad [-1.43520] \quad [0.85104]$$
$$+ 1.018682 LNM2 - 0.668293 LNRs - 0.061526 LNS$$
$$[-0.48051] \quad [1.28546] \quad [0.05624]$$
$$-0.032246 Trend - 27.32223$$
$$[2.44641] \tag{43}$$

In equation (43), only *LNCPI* and trend term have significant explanatory power to *LNSHA*. Comparing to the cointegration equation (41) of period 1, fewer variables showed their necessity in this long-run equilibrium equation.

Equation (43) can be transformed into error correction model:

$$\Delta LNSHA_t = -0.381865 ECM_{t-1} + 0.090863 \Delta LNSHA_{t-1} + 0.0.196043 \Delta LNSHA_{t-2}$$
$$[-2.49486] \quad [0.47415] \quad [0.97043]$$
$$+ 0.235717 \Delta LNSHA_{t-3} + 0.559210 \Delta LNCPI_{t-1} + 1.908031 \Delta LNCPI_{t-2}$$
$$[1.17344] \quad [0.33637] \quad [1.25347]$$
$$- 1.852677 \Delta LNCPI_{t-3} + 0.388298 \Delta LNIP_{t-1} + 0.082780 \Delta LNIP_{t-2}$$
$$[-1.14788] \quad [1.16334] \quad [0.22288]$$
$$+ 0.241995 \Delta LNIP_{t-3} - 1.396771 \Delta LNLOAN_{t-1} - 0.814919 \Delta LNLOAN_{t-2}$$
$$[0.75012] \quad [-0.86661] \quad [-0.51854]$$
$$- 1.459381 \Delta LNLOAN_{t-3} + 1.250749 \Delta LNM2_{t-1} + 1.269874 \Delta LNM2_{t-2}$$
$$[-0.92845] \quad [0.77563] \quad [0.66327]$$
$$+ 2.312176 \Delta LNM2_{t-3} - 0.055938 \Delta LNRs_{t-1} + 0.336487 \Delta LNRs_{t-2}$$
$$[1.40012] \quad [-0.07272] \quad [0.49904]$$
$$- 0.432761 \Delta LNRs_{t-3} + 0.523577 \Delta LNS_{t-1} - 0.085958 \Delta LNS_{t-2}$$
$$[-0.66890] \quad [0.40052] \quad [-0.06731]$$
$$+ 0.332907 \Delta LNS_{t-3} - 0.048946$$
$$[0.27640] \quad [-1.39030] \tag{44}$$

Unfortunately, in ECM (44), except for long-run equilibrium term ECM_{t-1} has a t-value of -2.49486, we can not find any other variables can significantly affect $\Delta LNSHA_t$.

4.4.3. Granger causality test

When looking at Granger causality between the cointegrated series *LNSHA*, *LNIP*, *LNLOAN*, $LNM2$, *LNRs* and *LNS* in table 17, we can find pretty strong Granger causality between those series at approximately 10% level, that *LNIP, LNLOAN*, *LNM2* and *LNS* Granger cause *LNSHA*, *LNSHA* is the Granger cause of *LNCPI*, *LNIP*, *LNLOAN*, *LNM2*, and *LNS*.

Table 17 Granger causality test for period 2.

Granger Causality Test(Jan.2001-Dec.2005) Null Hypothesis	Obs. 58 F-Statistic	Lags 3 Probability
LNCPI does not Granger Cause LNSHA	1.54406	0.21466
LNSHA does not Granger Cause LNCPI	2.3665	0.08197*
LNIP does not Granger Cause LNSHA	2.26651	0.09215*
LNSHA does not Granger Cause LNIP	2.18779	0.10105*
LNLOAN does not Granger Cause LNSHA	2.11218	0.11042*
LNSHA does not Granger Cause LNLOAN	2.12759	0.10844*
LNM2 does not Granger Cause LNSHA	2.22299	0.09697*
LNSHA does not Granger Cause LNM2	2.31098	0.08747*
LNRS does not Granger Cause LNSHA	0.68983	0.56254
LNSHA does not Granger Cause LNRS	0.97478	0.4121
LNS does not Granger Cause LNSHA	2.55811	0.06551*
LNSHA does not Granger Cause LNS	2.16903	0.1033*

*** denotes to significant at 1% level

** denotes to significant at 5% level

* denotes to significant at 10% level

Summing up the result of cointegration test, ECM and Granger causality of period 2, it is clearly that few macro economic indicators are affecting stock prices significantly in cointegration equation and ECM. One reason of why macroeconomic indicators does not strongly related to stock markets in period 2 may due to the deviation of macro economy and stock markets.

If we look at the line graph of macroeconomic indicators and stock index (see Appendix I), interestingly the behaviors of macroeconomic indicators reflects that macro economy is growing, as export, fixed asset investment, industrial output rose dramatically, M1, M2 went up and interest rate was decreasing, all the signs indicated the government took slack fiscal policies, ironically the stock markets fall into four year long bear market starting from June, 2006 till 2005. One wild accepted argument of the cause of bear market is the policy of reducing state-owned shares; Lin Song (2005) studied stock return volatility of two regimes: one after the policy is announced and one after the other policy of stops carrying out reducing state-owned shares. He found out that in both regimes, volatility of stock price increased apparently, and asymmetric was also observed that downward shocks caused more volatility in the near future than positive shocks. There were many voices of other factor related to the bear market, such as the unhealthy structure of financial agencies or life cycle of stock markets, unfortunately no empirical studies were found to support these ideas.

Table 18 calculates of each period, the number of statistically significant variables or relationships in cointegration equation, ECM and Granger causality respectively. It is shown that 8 Granger causalities are observed in period 1 and 9 in period 2, while in the whole sample period the case is 4. However, there is one problem of Granger causality test that sometimes it may not indicate the real case, since there’s no long-run equilibrium factor in the Granger causality function, so the effect of the long-run factor sort of split into each short term past values and will therefore increase the significance. Remind the ECM of period 1 and 2, equation (42) and (44), except for error correction term, almost no short term variable shows there significance, indicating that the significance in Granger causality test is actually aroused from the absence of long-run equilibrium factor. As we continue to compare the result of period

1, period 2 and the whole sample period, there's no strong evidence can prove that macroeconomic indicators are more related to stock index in period 2 than period 1; and both periods show weaker relationship than the whole sample period. One most possible reason for why not many strong relationships are shown in either period 1 or period 2 may be that we have a relative small sample, 60 monthly data for each period. Up to this point, we can reject the hypothesis that relationship between stock index and macroeconomic indicators are stronger in period 2 than period 1.

Table 18 Numbers of significant relationship of different test in each period.

	Cointegration Equation	ECM	Granger Causality
Whoel Sample Period	8	6	4
Period 1	7	2	8
Period 2	1	1	9

5. CONCLUSIONS

Chinese economy has experienced rapid growth in the past decade, the market capitalization of stock market surpassed GNP of last year for the first time in 2007, which means that Chinese stock market steps on an new stage. Many studies had been focusing on the role of stock market playing in the macro economy of world wide, yet few researchers studied the case of Chinese stock market.

This paper investigates the relationship between Shanghai stock index and nine macro economic indicators, namely CPI, export, fixed asset investment, industrial output, domestic loan, M1, M2, short-term interest rate and savings in the regime of Jan. 1996 to Dec. 2005. Furthermore, in order to investigate whether such relationship has become stronger over time, the whole sample period was divided into two stages, 5 years long of each.

Cointegration test, error correction model (ECM) and Granger causality test are adopted in this paper. Cointegration equation can reveals the long-run equilibrium state of the non-stationary macroeconomic or financial time series, and the equivalent ECM shows the short-run relationship as well as short-run adjusting parameters towards the long run steady state relationship. Granger causality test investigates whether the history values of one time series help to predict another series.

Of the whole period, firstly, all time series turn out to be I (1), which is usually the case the financial time series. In the state of long-run equilibrium, CPI, export, fixed asset investment, industrial output, domestic loan, M1, short-term interest rate and savings are statistical significantly related to Shanghai stock index. Moreover, CPI, industrial output, M1 and savings are positively related to stock index; fixed asset investment, domestic loan and short-term interest rate are negatively related to stock index. The reason why some relationship do not obey economic theory may because that during the whole sample period, the stock market finished a life cycle, 5 years of rising and 5 years of drop, while the economic was growing all the time. It is reasonable to assume that if we can enlarge the sample period, we can get more satisfying result.

Secondly, in error correction model, stock index is negatively related to error correction term, which means that in order to converge to the long-run equilibrium state, the stock index should rise in the future. In additional, stock index is positively affected by one lag of export and fixed asset investment, and negatively affected by one lag of M1, short-term interest rate and savings. Five out of nine macroeconomic indicators influence stock index significantly in ECM, which suggests that in short run stock index and macro economy are to some extent connected.

Thirdly, in Granger causality test of the whole sample period not many correlations between stock index and macroeconomic indicators are revealed. Taking lag length of two, fixed asset investment and M1 Granger cause stock index and stock index Granger cause M2 and savings.

Generally speaking, in the whole sample period, strong relationships are shown between stock index and macroeconomic indicators in the long term, for short-run, they are to some extent correlated, five out of nine macroeconomic indicators have explanatory power to stock index.

Moreover, in period 1 also strong correlation was discovered between stock index and macroeconomic series in the long term. However in period 2, due to the deviation of stock market and macro economy, only one economic indicator are significantly related to stock index in the long run. In addition, almost no correlation was found in the short term in either period 1 or 2. Interestingly, twice as many Granger causalities in period 1 and 2 as in the whole sample period was found. Nonetheless in Granger causality thermo no long term error correction term is considered and it is reasonable to doubt that the significant Granger causalities were actually exaggerated. To conclude we can safely say that relationship between stock index and macro economy has not become strong in period 2 than period 1.

Unlike previous literatures focused on single or few indicators, this paper studies the relationship between stock index and nine macroeconomic indicators, which as whole reflects the condition of Chinese macro economy. In addition, this paper also divide the whole period in to two regimes and discovered that although such relationship is strong of the whole period, it is not the case in period 2, suggesting that the stock market might also greatly affected by policies, which serves a topic for further studies.

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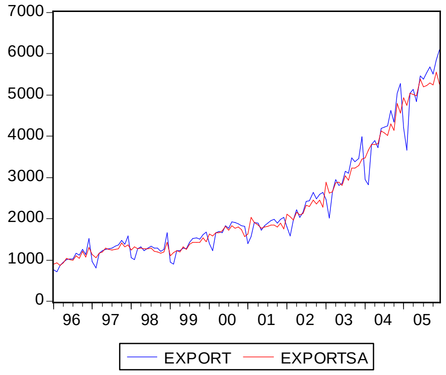
APPIDICES

I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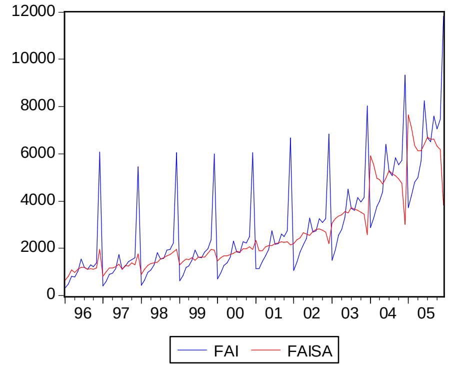
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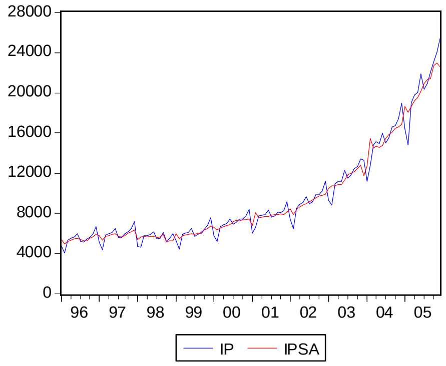
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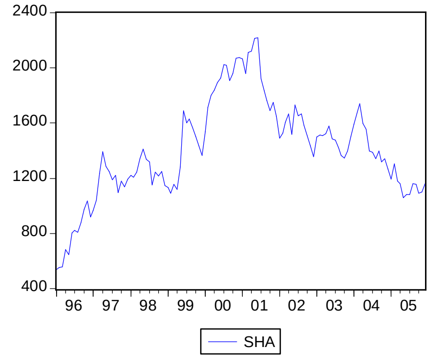
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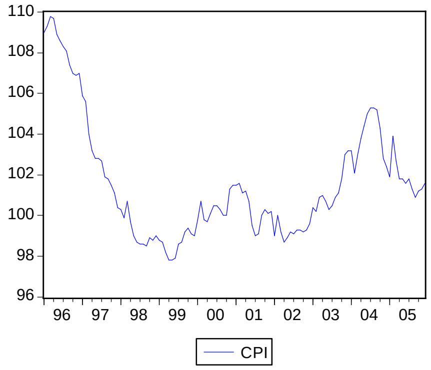
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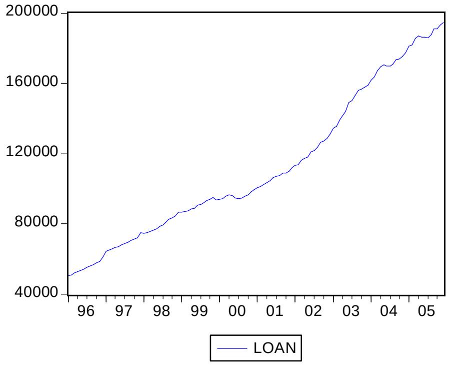
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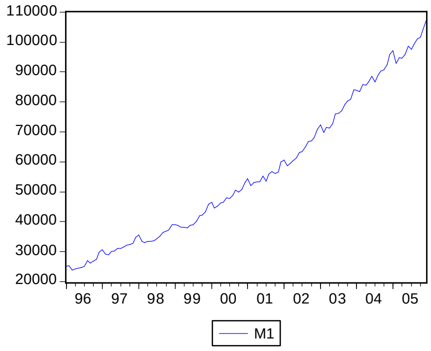
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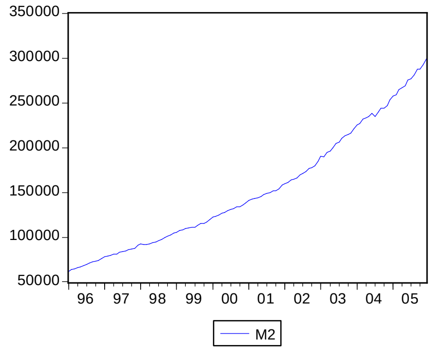
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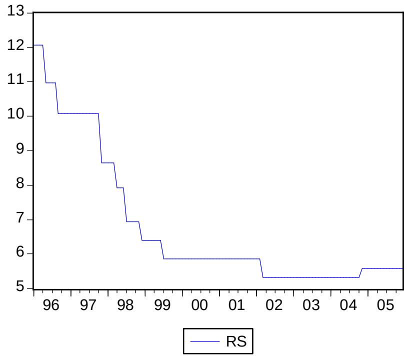
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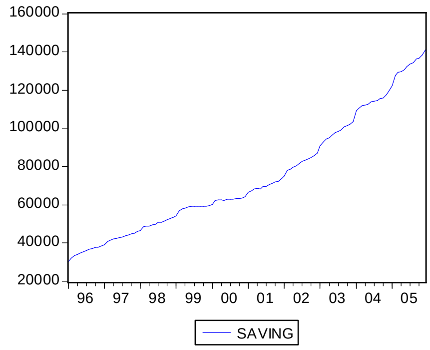
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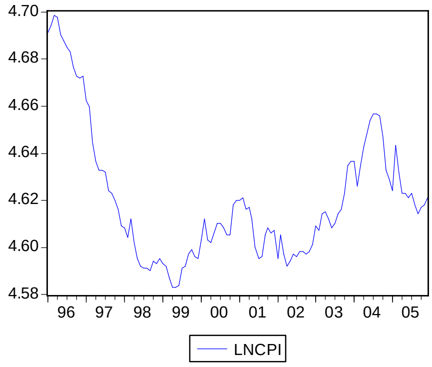
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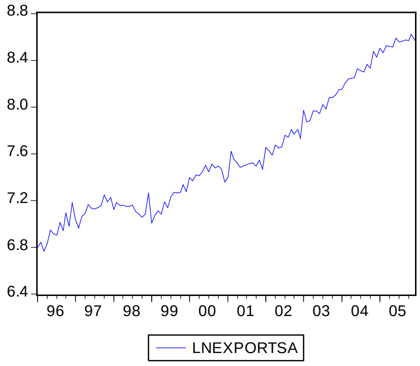
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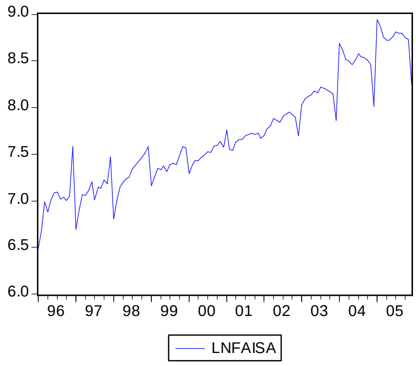
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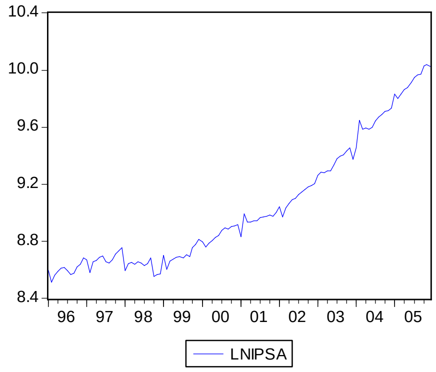
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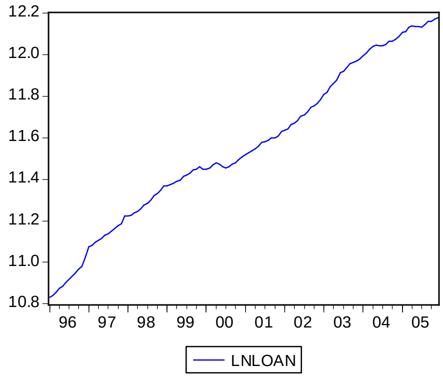
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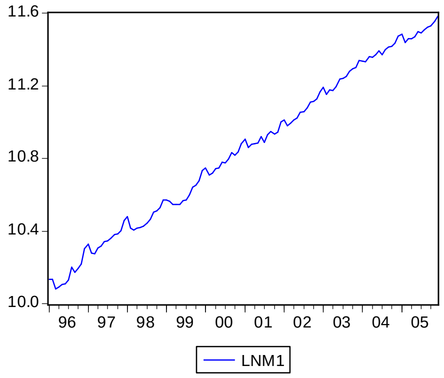
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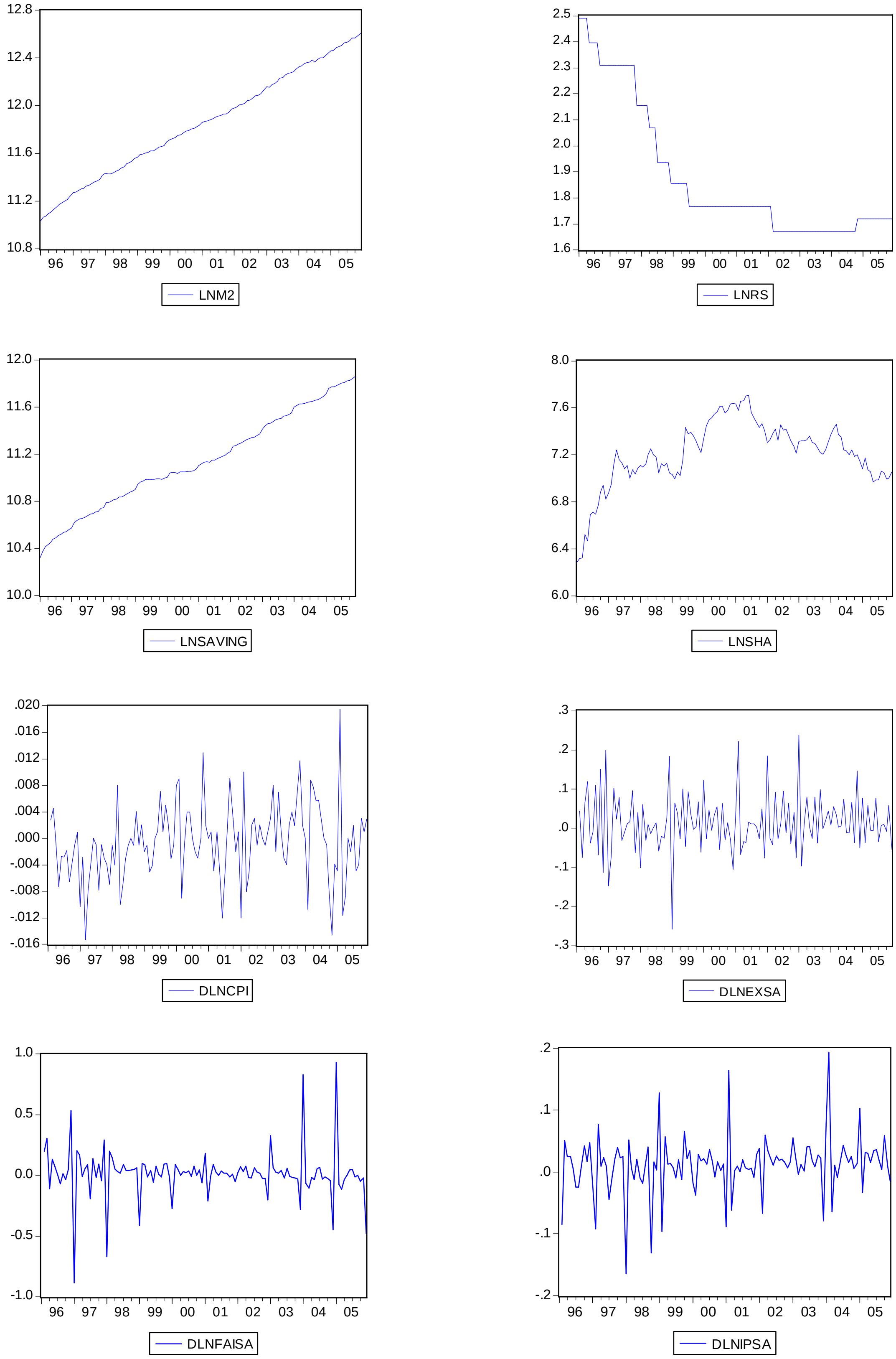

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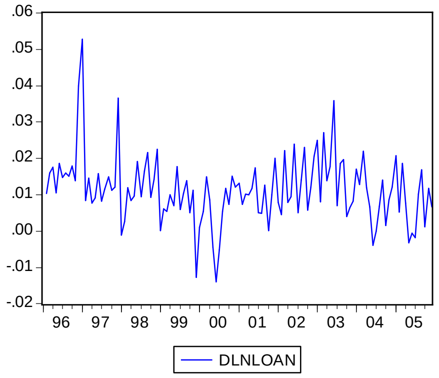
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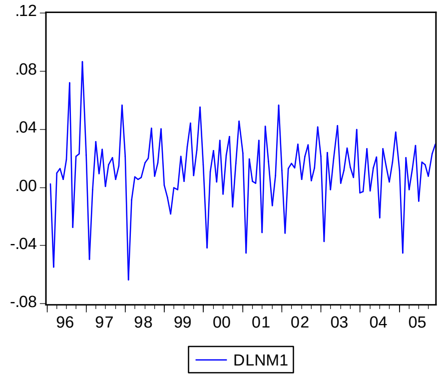
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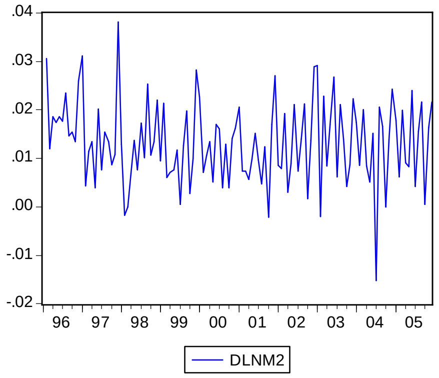
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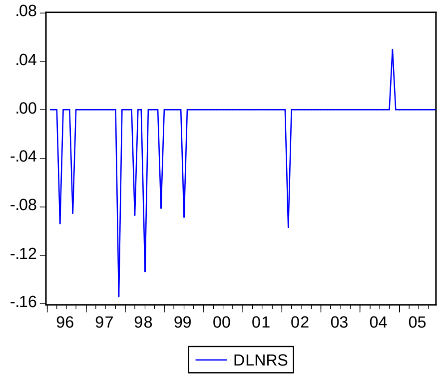
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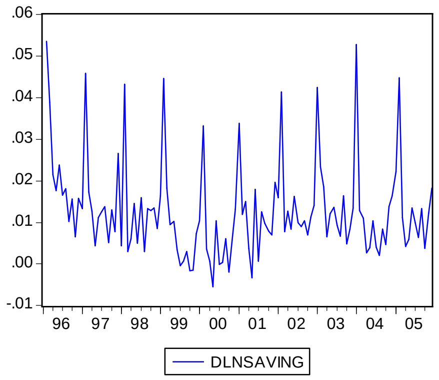
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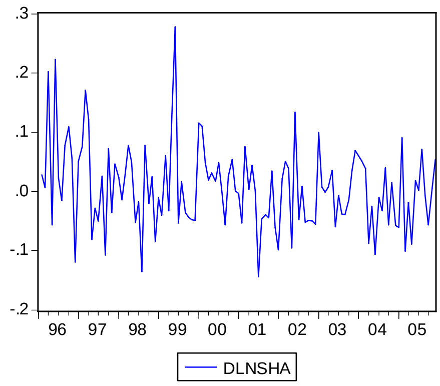
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	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary	Type (c,t,p)	t-value	Critical value (1% level)	Critical value (5% level)	Stationary
LNCPI	(c,t,12)	-3.097768	-4.046072	-3.452358	no	(c,t,0)	-2.185877	-4.036983	-3.448021	no	(c,t,4)	-2.186856	-4.036983	-3.448021	no
D(LNCPI)	(-,-,11)	-2.521416	-2.586753	-1.943853	Stationary*	(-,-,0)	-9.343578	-2.584707	-1.943563	Stationary	(-,-,0)	-9.343578	-2.584707	-1.943563	Stationary
LNEX	(c,t,4)	-0.831673	-4.039797	-3.449365	no	(c,t,2)	-1.113528	-4.038365	-3.448681	no	(c,t,2)	-2.31918	-4.036983	-3.448021	no
D(LNEX)	(c,-,5)	-4.156149	-3.489117	-2.88719	Stationary	(c,-,1)	-11.78193	-3.487046	-2.88629	Stationary	(c,-,12)	-21.09295	-3.486551	-2.886074	Stationary
LNFAI	(c,t,12)	-0.624708	-4.046072	-3.452358	no	(c,t,12)	-0.624708	-4.046072	-3.452358	no	(c,t,6)	-7.655537	-4.036983	-3.448021	Stationary
D(LNFAI)	(c,-,12)	-3.301228	-3.493129	-2.888932	Stationary*	(c,-,11)	-4.503046	-3.492523	-2.888669	Stationary					
LNIP	(c,t,5)	0.144547	-4.040532	-3.449716	no	(c,t,3)	-0.167468	-4.039075	-3.44902	no	(c,t,17)	-1.17208	-4.036983	-3.448021	no
D(LNIP)	(c,-,10)	-1.129655	-3.491928	-2.888411	no	(c,-,0)	-15.18426	-3.486551	-2.886074	Stationary	(c,-,9)	-15.67364	-3.486551	-2.886074	Stationary
LNLOAN	(c,t,12)	-3.075502	-4.046072	-3.452358	Stationary*	(c,t,0)	-1.867286	-4.036983	-3.448021	no	(c,t,5)	-2.033186	-4.036983	-3.448021	no
D(LNLOAN)	(c,-,12)	-2.790316	-3.493129	-2.888932	Stationary**	(c,-,0)	-8.327205	-3.486551	-2.886074	Stationary	(c,-,3)	-8.444857	-3.486551	-2.886074	Stationary
LNM1	(c,t,12)	-2.970419	-4.046072	-3.452358	no	(c,t,12)	-2.970419	-4.046072	-3.452358	no	(c,t,4)	-5.046208	-4.036983	-3.448021	Stationary
D(LNM1)	(c,-,12)	-2.063844	-3.493129	-2.888932	no	(c,-,11)	-2.863716	-3.492523	-2.888669	Stationary**	(c,-,7)	-12.60723	-3.486551	-2.886074	Stationary
LNM2	(c,t,12)	-2.115141	-4.046072	-3.452358	no	(c,t,0)	-3.861893	-4.036983	-3.448021	no	(c,t,17)	-3.832966	-4.036983	-3.448021	Stationary
D(LNM2)	(c,-,11)	-3.868215	-3.492523	-2.888669	Stationary	(c,-,1)	-9.507428	-3.487046	-2.88629	Stationary					
LNRs	(c,t,8)	-1.06984	-4.042819	-3.450807	no	(c,t,0)	-1.19527	-4.036983	-3.448021	no	(c,t,6)	-1.053053	-4.036983	-3.448021	no
D(LNRs)	(c,-,7)	-2.531732	-3.49021	-2.887665	no	(c,-,0)	-11.41673	-3.486551	-2.886074	Stationary	(c,-,4)	-11.41376	-3.486551	-2.886074	Stationary
LNS	(c,t,12)	-2.532969	-4.046072	-3.452358	no	(c,t,12)	-2.532969	-4.046072	-3.452358	no	(c,t,4)	-3.297069	-4.036983	-3.448021	no
D(LNS)	(c,t,11)	-2.231027	-3.492523	-2.888669	no	(c,-,0)	-9.045196	-3.486551	-2.886074	Stationary	(c,t,4)	-9.012877	-3.486551	-2.886074	Stationary
LNSHA	(c,t,0)	-2.60352	-4.036983	-3.448021	no	(c,t,0)	-2.60352	-4.036983	-3.448021	no	(c,t,7)	-2.591439	-4.036983	-3.448021	no
D(LNSHA)	(-,-,2)	-6.462628	-2.58505	-1.943612	Stationary	(-,-,0)	-10.5484	-2.584707	-1.943563	Stationary	(-,-,1)	-10.54786	-2.584707	-1.943563	Stationary

Note: LN means the logarithm form of each series; -SA means the series were seasonal adjusted before used; D ( ) is the first difference of series; c, t, p denotes to intercept, trend and lag. * means significant at 5% level while ** means significant at 10% level.

APPIDIX III

Critical Values for the T Distribution (Degrees of Freedom are given in the first column.)

One-Sided Significance Levels (double for Two-Sided)

DF	0.2	0.1	0.05	0.025	0.02	0.01	0.005
1	1.376	3.078	6.314	12.706	15.894	31.821	63.656
2	1.061	1.886	2.920	4.303	4.849	6.965	9.925
3	0.978	1.638	2.353	3.182	3.482	4.541	5.841
4	0.941	1.533	2.132	2.776	2.999	3.747	4.604
5	0.920	1.476	2.015	2.571	2.757	3.365	4.032
6	0.906	1.440	1.943	2.447	2.612	3.143	3.707
7	0.896	1.415	1.895	2.365	2.517	2.998	3.499
8	0.889	1.397	1.860	2.306	2.449	2.896	3.355
9	0.883	1.383	1.833	2.262	2.398	2.821	3.250
10	0.879	1.372	1.812	2.228	2.359	2.764	3.169
11	0.876	1.363	1.796	2.201	2.328	2.718	3.106
12	0.873	1.356	1.782	2.179	2.303	2.681	3.055
13	0.870	1.350	1.771	2.160	2.282	2.650	3.012
14	0.868	1.345	1.761	2.145	2.264	2.624	2.977
15	0.866	1.341	1.753	2.131	2.249	2.602	2.947
16	0.865	1.337	1.746	2.120	2.235	2.583	2.921
17	0.863	1.333	1.740	2.110	2.224	2.567	2.898
18	0.862	1.330	1.734	2.101	2.214	2.552	2.878
19	0.861	1.328	1.729	2.093	2.205	2.539	2.861
20	0.860	1.325	1.725	2.086	2.197	2.528	2.845
30	0.854	1.310	1.697	2.042	2.147	2.457	2.750
40	0.851	1.303	1.684	2.021	2.123	2.423	2.704
50	0.849	1.299	1.676	2.009	2.109	2.403	2.678
60	0.848	1.296	1.671	2.000	2.099	2.390	2.660
70	0.847	1.294	1.667	1.994	2.093	2.381	2.648
80	0.846	1.292	1.664	1.990	2.088	2.374	2.639
90	0.846	1.291	1.662	1.987	2.084	2.368	2.632
100	0.845	1.290	1.660	1.984	2.081	2.364	2.626