Overreaction Index for Stock Markets

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Abstract: The note proposes a new macroeconomic index, which measures overreactions of stock markets. The empirical results based on Nikkei average stock price in Japan shows that the new index clearly describes the underestimation of the macroeconomy for the periods after the crush of IT bubble. The empirical results also indicate that the new index has a predictive power of the future GDP growth. After the Lehman shock, there is a tendency of the stock market to underestimate the economic condition.

Keywords: Leading indicator, Stock markets.

JEL Classification: C20, G10

1 Introduction

Stock price has been considered as the leading indicator of macroeconomy. For instance, if the dividend discount model is used, the fundamental value of the stocks may be regarded as a function of the past macroeconomic variables, since they constitute information sets to generate flow of expected future income. The results in Fama (1990) showed that stock returns explain significantly the variation in future real activity, such as industrial production index.

In the studies of early 90’s, several authors such as Balvers, Cosimano and MacDonald (1990), Barro (1990), Fama (1990), Schwert (1990), Chen (1991), Cochrane (1991), and Ferson and Harvey (1991) have found that stock returns and real economic activity are correlated. Binswanger (2000) provides recent evidence in U.S., showing that large fractions in stock markets are considered to make such a relation very weak.

From the viewpoint of dividend discount model, the gap between stock market index and desirable state would be an overreaction to shocks. This note focuses on the gap. Section 2 suggests a new index to measure overreactions of the markets. Section 3 gives empirical results of the index for Japan, and investigates its effects to future economy.

2 Overreaction Index

By comparing the gap between stock market price and its desirable state, the note
proposes a new monthly index. In order to consider the real economic activity, the GDP is the most appropriate variable. For the purpose predicting future state, we may use a forecast of the GDP. However, since it is reported quarterly, the GDP may not be used for the monthly purpose.

As a proxy of the desirable state of stock markets, the note works with leading economic indicators. Let \( P_t \) and \( F_t \) be the price of a stock market index and the value of a leading economic indicator, respectively. The new index is given by

\[
I_t = (P_t - a_t F_t - b_t F_t) / s_t
\]

where \( a_t \), \( b_t \) and \( s_t \) are OLS estimates of \( a \), \( \beta \) and \( \sigma \) in the regression

\[
P_t = a + \beta F_t + v_t, \quad E(v_t) = 0, \quad V(v_t) = \sigma^2, i = t - 120, \ldots, t - 1.
\]

By construction, the index is based on not only current \( P_t \) and \( F_t \), but also the information of the past ten years. For convenience, the note calls \( I_t \) as the “Overreaction Index” of stock markets, as the purpose is to detect overreactions.

The background of the overreaction index is as follows. Usually, the two process, \( \{ P_t \} \) and \( \{ F_t \} \) have unit roots. Under the assumption that \( \{ P_t \} \) is in the desirable state, the co-integration relationship would hold between \( \{ P_t \} \) and \( \{ F_t \} \). Given the co-integration, the numerator of the overreaction index \( P_t - a_t F_t \) is an estimate of the error term based on the co-integrating vector from the data of past ten years. If the current \( P_t \) is also in the desirable state, the overreaction index \( I_t \) is considered to be a sample of the random variable with mean zero and variance one. If the current \( P_t \) is far from the desirable state, the index \( I_t \) will take an extreme value.

Even if the process \( \{ P_t \} \) is far from the desirable state, the OLS estimates, \( a_t \) and \( b_t \), have super-consistency (Stock (1987)). In this case, the residuals from the regression model (2) are also super-consistent, and hence \( s_t \) is the consistent estimator of \( \sigma \). With respect to the overreaction index, there is no guarantee to take an extreme value under the condition that the current \( P_t \) is far from the desirable state. If the co-integration relationship does not hold, the overreaction index should be used conservatively.

As shown in the next section, the test statistic proposed by Engle and Granger (1987) rejects the null hypothesis of no co-integration, for the case of Japan.

For the value of the overreaction index, the note classifies the state of the stock market into five categories, “Underestimation”, “Caution of Underestimation”, “Sound State”, “Caution of Overestimation”, and “Overestimation”, as shown in Table 1. The values \((-2, \ -1.5, \ 1.5, \ 2)\), which distinguish the categories, correspond to \((2.3, \ 6.7, \ 93.3, \ 97.7)\) percentiles of the standard normal distribution.

The effect of overreaction to the GDP should be investigated. Let \( Y_t \) be the quarterly
growth rate of the GDP for the period $s$. Let $I_{s,j}$ be the $j$th month for the period $s$. The regression based on quarterly data is given by

$$Y_{s+1} = \beta_0 + \beta_1 I_{s,1} + \beta_2 I_{s,2} + \beta_3 I_{s,3} + \epsilon_s.$$  

(3)

In words, the regression checks the predictive power of the future GDP, using the overreaction index.

3 Empirical Results

The datasets used in this section are the Nikkei average stock price (Nikkei) and the Composite Index–Leading Indicator (CI–Lead) in Japan. The sample period is January 1991 to February 2009, giving 216 observations.

Before constructing the proposed index, the unit roots and co-integration for $(P_t, F_t)$ should be investigated. The augmented Dickey–Fuller (ADF) tests with constant and trend terms are conducted. As the data are seasonally unadjusted, the lag length is chosen to be 12. The results are shown in Table 2. For Nikkei and CI–Lead, the ADF test statistics did not reject the null of unit root with five percent level.

Secondly, the test for co-integration suggested by Engle and Granger (1987) is conducted. In the EG test, co-integrating vector is estimated in the first step, and the ADF test without constant and trend terms is conducted in the second step. In this case, the null hypothesis is no co-integration, which corresponds to a unit root in the residual process. The result of the EG test shown in Table 2 indicates that there is a co-integration relationship between Nikkei and CI–Lead.

<table>
<thead>
<tr>
<th>Test</th>
<th>ADF</th>
<th>EG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis</td>
<td>Unit Root</td>
<td>No Co-integration</td>
</tr>
<tr>
<td>Series</td>
<td>Nikkei</td>
<td>CI–Lead</td>
</tr>
<tr>
<td>Test Statistic</td>
<td>$-7.798$</td>
<td>$-15.934$</td>
</tr>
</tbody>
</table>

Note: The ADF tests and the second step of the EG test are based on 12 lags. The former test works with constant and trend terms, while the latter excludes them. *denotes significant at 5% level.
Figure 1 Overreaction Index

Table 3 Predictability by Overreaction Index

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$\hat{\beta}_0$</th>
<th>$\hat{\beta}_1$</th>
<th>$\hat{\beta}_2$</th>
<th>$\hat{\beta}_3$</th>
<th>$\hat{\beta}_4$</th>
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</thead>
<tbody>
<tr>
<td>Estimate (HCSE)</td>
<td>0.0027</td>
<td>0.0896</td>
<td>-0.0596</td>
<td>-0.0309</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0107)</td>
<td>(0.0407)</td>
<td>(0.0696)</td>
<td>(0.0487)</td>
<td></td>
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<tr>
<td>Std. Error</td>
<td>0.0543</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>$R^2$</td>
<td>0.1164</td>
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</tbody>
</table>

Note: HCSE denotes the heteroskedasticity-consistent standard error.

For constructing the overreaction index, the estimates of the parameters are required in the regression model (2), based on the observations of past ten years. For this reason, the first 120 observations are used to obtain $a_t$, $b_t$, and $s_t$, in order to calculate the value of overreaction index at January 2001. Figure 1 shows the time series plots of the overreaction index with border lines. The index indicates the ‘Underestimation’ from January 2001 to July 2003. The periods for underestimation of the Japanese economy clearly correspond to the burst of the IT bubble and the recovery in U.S. After the Lehman shock in October 2008, there is a tendency for Nikkei to underestimate the economy.

Table 3 gives the OLS estimates for the regression (3). The estimate of $\hat{\beta}_1$ is positive and significant at five percent level, implying that the overreaction index of the first month of the current quarter contributes to predicting the growth rates of the next quarter. Hence, the overestimation in the stock market pushes up the growth rates of GDP, while the underestimation pulls it down. Although $R^2$ shows the effect is small, it is not negligible.

4 Conclusion

The note proposed the overreaction index for stock markets. Depending on the value of
the index, the state of stock market can be classified to five categories, namely, “Underestimation”, “Caution of Underestimation”, “Sound State”, “Caution of Overestimation”, and “Overestimation”. The empirical results for Japan showed that Nikkei underestimates the Japanese economy for the periods after the burst of IT bubble in U.S. The empirical results also indicated that the overreaction index have power for predicting the growth rate of the GDP.

After the Lehman shock, the stock market has a tendency to underestimate the economic condition. The stock market should avoid such an overreaction, for preventing negative effects on the GDP growth rate.

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