E C O N O M I C S B U L L E T I N

The Relationship between Stock Price and EPS: Evidence Based on Taiwan Panel Data

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Abstract

In this study, we use panel cointegration methods to investigate the relationship between stock prices and earnings-per-share (EPS). Furthermore, we consider whether stock prices respond to EPS under the different level of growth rate of operating revenue. The empirical result indicated that the cointegration relationship existed between stock prices and EPS in the long-run. Furthermore, we found that for the firm with a high level of growth rate, EPS has less power in explaining the stock prices; however, for the firm with a low level of growth rate, EPS has a strong impact in stock prices.

Citation: Chang, Hsu-Ling, Yahn-Shir Chen, Chi-Wei Su, and Ya-Wen Chang, (2008) "The Relationship between Stock Price and EPS: Evidence Based on Taiwan Panel Data." *Economics Bulletin*, Vol. 3, No. 30 pp. 1-12
Submitted: February 11, 2008. **Accepted:** May 24, 2008.
URL: http://economicsbulletin.vanderbilt.edu/2008/volume3/EB-08C30034A.pdf

1. Introduction

The phenomenon of the mean-reversion discussed from the literatures explore whether the stock price followed random walk. If the stock prices violate the trend of random walk, one possibility is the stock prices followed mean-reversion process. If the stock prices followed mean reversion in the long-run, the price movements should be predictable from the movements in firm fundamental values. In this sense, determining whether stock prices are mean-reversion is a very important issue for investors. Consequently, to analysis equity fundamentals, what is important is to verify whether the stock price moves with its firm's fundamental. Proxies for firm's fundamental values used in previous studies include earnings-per-share (EPS), earnings, dividends and net asset values (NAV).

In previous surveys, there was strong evidence that stock prices followed mean reversion process in several stock markets such as U.S., Spanish, and Singapore stock markets, which have been defined in various ways. The dividends-to-price ratio (Fama and French, 1988) and earnings-to-price ratio (Campell and Shiller, 1988) are found to contribute significantly to the explanation of long-term stock price variation. Chiang et al. (1995) use earnings and dividends as proxies of fundamental values found that stock returns follow a mean-reversion process and their findings are consistent with those of Campbell and Shiller (1988). Ansotegui and Esteban (2002) established a long-run relationship between the Spanish stock market and its fundamentals, and checked to which extent this relationship helps in forecasting. Sing et al. (2002) examined the relationship between the stock price and the fundamentals for Singapore and found that the mean-reversion of stock prices towards fundamental value.

The future profit of the firm is the most fundamental factor that affects stock prices and the earnings information was considered to contain the greatest informational content of all the accounting information because it contains the important discussion concerning the relationship between accounting earnings and stock prices. The study measures the magnitude stock prices respond to EPS based on earnings response coefficient (ERC) and it is used as a measure of timeliness of accounting earnings which reflects the value relevance of accounting number. Value relevance is defined as the degree of association between accounting information and market value, while timeliness is defined as the extent to which accounting information co-varies with market values.

Ball and Brown (1968) first used the security Abnormal Performance Index (API) to measure the variation of annual stock price. Freeman (1987) investigated the relationship between the accountings earnings and stock returns in big companies and small companies. Beaver, Lambert and Morse (1980) reverse the direction of the

relationship and examined the information content of prices with the change in earnings as the dependent variables and find the variations of stock prices have significant correlation with the variations of earnings. Beaver, Lambert and Ryan (1987) eliminate the errors of regression parameters, to investigate whether the explanatory power existing in the variations of past stock prices versus the variations of current earnings. Furthermore, the variations of past stock prices are significant to the variations of current earnings. The earnings information content studied previously, all assumed the ERCs are constant in the separate firms or the different years, however, the assumption showed a lack of propriety. The major problem is that the earnings represent the current information, but stock prices are a long-term concept, they represent the present values of the future cash flows. Kormendi and Lipe (1987) add earnings persistence to explore the relation on the premise that the earnings have information content. Beaver, McAnally and Stinion (1997) consider that both the earnings and stock prices are affected by information and interact with each other. They use the simultaneous equations to review the relation between the stock prices and the earnings and find that the feedback relationship exists between the two variations.

However, the above-mentioned surveys have some disadvantages. First, they may have lower power because of limited data. If data was included for a longer period of time, structural problems might have occurred. Second, they could have subdivided the data to months or quarters to increase the frequency, but Hakkio and Rush (1991) have shown that the subdivision do not improve the test power. Besides, there exists a non-stationary problem for stock prices and EPS, the non-stationary may lead to the problem of spurious regression for previous studies. Accordingly, we can use panel data to improve the test power, that is because panel data combine cross section and time series data and it can provide a great improvement in the power of tests by increasing the number of the observations. Moreover, the non-stationary problem may be dealt with panel data proposed by Levin et al. (2002). Furthermore, we can use the panel cointegration method to yield the unbiased estimator.

In this study we focus on examining the relation between stock prices and EPS in Taiwan’s stock market. After testing whether or not both series are non-stationary, we will use Pedroni (1995, 1999, 2000) panel cointegraion test to determine their long-term relationship. It means that we will test whether stock prices and EPS are cointegrated. Furthermore, in order to determine the magnitude that stock prices responds to EPS, we use Kao and Chiang (2000) and Pedroni (2000, 2001) panel cointegration method to estimate the unbiased ERCs. Finally, we investigate whether there is a difference for dissimilar growth rate of operating revenue.

The remainder of this study is organized as follows. Section 2 presents the theory

model. Section 3 describes the methodologies including kinds of the panel unit root, cointegration tests, cointegration coefficient estimation. Section 4 presents the data and empirical results. Section 5 concludes this paper.

2. The Model

In the analysis of stock prices, the relationship between stock prices and EPS is investigated. First we explore the degree that stock prices response to EPS. If the stock prices move with EPS, we can say that the stock prices follow mean-reversion process; it means prices respond to the intrinsic assets value of the firm. If the stock prices follow mean-reversion process, we should have the following two conditions: (a) cointegration of the variables; and (b) a positive value for β.

Now consider the relationship between stock prices and EPS, as follows:

$$S_{i,t} = \alpha_i + \beta_i EPS_{i,t} + e_{i,t} \quad (1)$$

with $$EPS_{i,t} = EPS_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

and $$S_{i,t} = S_{i,t-1} + u_{i,t} \quad (3)$$

Here, S_t is the stock prices, and EPS stands for earnings-per-share. $e_{i,t}$, $\varepsilon_{i,t}$ and $u_{i,t}$ are normal distributed error-terms with zero expected mean, constant variance and not autocorrelation. $EPS_{i,t}$ is the earnings-per-share of firm i and $P_{i,t}$ is the price of firm i at time t.

The above model is a benchmark in the value relevance studies firstly proposed by Ball and Brown (1968). The slope coefficient β is called earnings response coefficient (ERC) and is expected to be 1/r or close to 1/r, where r is the discount rate for future earnings.

3. Methodology

3.1 Panel Unit Root Tests

Stock prices and earnings data are usually non-stationary, if we use the traditional OLS method, it may produce spurious regression problem mentioned by Granger and Newbold (1974) and lead to statistical bias. Consequently, the study first examined whether the data is stationary data.

It is well known that the traditional unit root method (ADF test, PP test, KPSS test and Ng-Perron test) involve the low test power problem because of insufficient data. Panel data could increase the number of observations and time periods, hence, it can improve the power of tests. Levin, Lin and Chu (L-L-C, 2002) found that the panel approach substantially increases power by infinitely increasing sample size compared to the single-equation ADF test and proposed a panel-based version that restricts β by keeping it identical across-industries. L-L-C tested the null hypothesis of $\beta_1 = \beta_2 = ... = \beta < 0$, against the alternative of $\beta_1 = \beta_2 = ... = \beta < 0$. L-L-C test has

a disadvantage in that β is restricted by being kept identical across regions under both null and alternative hypotheses. Im, pesaran and Shin (IPS, 2003) relaxed the assumption that allows β varied across regions under the alternative hypothesis. The null hypothesis of IPS test is $\beta_1 = \beta_2 = ... = 0$ against the alternative of $\beta_i < 0$, for all i. Maddala and Wu (MW, 1999) developed a test based on the probability values of all root unit individual tests. MW test involves simulation methods, generally, more powerful than L-L-C test and IPS test. When the errors in the different samples (or cross-section units) are cross correlated, the Monte Carlo evidence suggests that it is less severe with the MW test than with L-L-C or IPS test. Hadri (2000) proposes residual based Lagrange Multiplier tests for the null hypothesis so that the time series for each cross section unit, i, are stationary around a level or around a deterministic time trend, against the alternative of at least a single unit root. In this method, the random error considered not only homogeneous but also heterogeneous variance. If we consider the heterogeneous condition, $\hat{LM}$ statistic value as follows:

$$\hat{LM} = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{1\Big/T^2\sum_{t=1}^{T}S_{it}^2}{\hat{\sigma}_{\varepsilon,i}^2}\right) \tag{4}$$

3.2 Panel Cointegration test

The next part of the process involves testing whether a cointegration relationship exist between the stock prices and EPS. This is achieved by applying the test developed by Pedroni (1995, 1999, 2000) that includes the pooled within-dimension based and group-mean panel cointegration statistics. It improves the power of test compared to conventional cointegration tests.

Pedroni (1995, 1999, 2000) proposed seven tests for cointegration in a panel context. Four of the statistics, called panel cointegration statistics, are pooled within-dimension based statistics. The other three statistics, called group-mean panel cointegration statistics, are between-dimension panel statistics. The former four statistics developed by Pedroni (1995, 1999), the latter three statistics developed by Pedroni (2000).

The statistics are calculated as follows:

Panel *v*-Statistic

$$Z_v = \left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^2\right)^{-1} \tag{5}$$

Panel ρ-Statistic

$$Z_{\rho} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right) \tag{6}$$

Panel non-parametric (PP) *t*-Statistic

$$Z_{pp} = \left(\sigma^2 \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^{2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{it} - \hat{\lambda}_i \right) \tag{7}$$

Panel parametric (ADF) *t*-Statistic

$$Z_{t} = \left(\hat{S}^{*2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1}^{*2} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{e}_{i,t-1} {}_{i,t-1} \Delta \hat{e}_{i,t}^{*} \tag{8}$$

Group ρ-Statistic

$$\tilde{Z}_{\rho} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}_{i,t-1}^{2} \right)^{-1} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right) \tag{9}$$

Group non-parametric (PP) *t*-Statistic

$$\tilde{Z}_{pp} = \sum_{i=1}^{N} \left(\hat{\sigma}^2 \sum_{t=1}^{T} \hat{e}_{i,t-1}^{2} \right)^{-1/2} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right) \tag{10}$$

Group parametric (ADF) *t*-Statistic

$$\tilde{Z}_{t} = \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{S}_{i}^{-2} \hat{e}_{i,t-1}^{*2} \right)^{-1/2} \sum_{t=1}^{T} \hat{e}_{i,t-1}^{*} \Delta \hat{e}_{i,t}^{*} \tag{11}$$

For the Pedroni cointegration test, the null hypothesis assumed no cointegration. While panel *v*-Statistic of the pooled panel cointegration statistics has a positive value, then it rejected the null hypothesis. If there are negative values for the other six statistics, we could reject the null hypothesis.

Pedroni proposed within-group and between-group test. In both tests, rejection of the null hypothesis means that the stock prices and EPS are cointegrated. In addition, the within-group test has an alternative hypothesis that constrains the autoregressive coefficient of the residuals to be homogeneous, whereas a between-group test has an alternative hypothesis that the autoregressive coefficient of the residual could be heterogeneous. Pedroni's (1995) Monte Carlo simulation shows that the powers of the between-group statistics are higher than that of the within-group statistics in small samples.

3.3 The ERCs Estimation of Panel Cointegrated Regression

Kao and Chiang (2000) proposed the asymptotic distributions for the ordinary least square (OLS), adjusted OLS, and dynamic OLS (DOLS) estimators. We use

OLS, adjusted OLS, and DOLS estimator to calculate ERCs. They find that the OLS and adjusted OLS estimators have non-negligible biases in finite samples and the DOLS estimator may be more promising than OLS estimator in estimating the cointegrated panel regressions. However, DOLS estimator proposed from Kao and Chiang (2000) does not deal with the alternative hypothesis of heterogeneous samples. Pedroni (2000, 2001) proposed two methods to apply fully modified method to panel cointegration regression: the pooled (within-group) and the group-mean (between-group) FMOLS estimators. We will use the between-group FMOLS estimator, because it allows for a more flexible alternative hypothesis and suffers much less form small sample size distortion than the within-group estimator. Consequently, the group-mean FMOLS estimator proposed from Pedroni (2001) could be more promising than the DOLS estimator proposed from Kao and Chiang (2000).

4. Empirical results

After deleting the insufficient data, we used quarterly data for 75 firms listed on the Taiwan Stock Exchange (TSEC) for the period from 1997 to 2006. A firm-level panel data set is constructed from the Taiwan Economic Journal (TEJ) database. In addition, in order to remove any forward-looking bias proposed by Banz and Breen (1986), the term covers a period of 10 years from 1997 to 2006 of the stock price and the fourth quarter 1996 to the third quarter 2006 of EPS. This study divided the firms into three dimensions by growth rate of operating revenue, where the first 25% firms attached to High-Growth firms; the lasted 25% firms attached to Low-Growth firms; the remaining 50% firms attached to Middle-Growth firms.

4.1 Results from the individual analyses

Table 1 indicates the results from the conventional Augmented Dickey-Fuller (ADF) unit root tests on the individual firms. The null hypothesis is that of a unit root (if we reject the null hypothesis, it means the data are stationary). Even if the tests for some individuals reject the unit root, most of the data are consistent with unit roots; consequently, it indicates that a non-stationary problem should be managed.

Table 1. The Unit Root test result from the individual firms

Variables	1%		5%	
	H_0 : reject	reject rate (%)	H_0 : reject	reject rate (%)
Stock prices	1/75	1.33	8/75	10.67
EPS	33/75	44	48/75	63.15

Notes: 1. It uses Augmented Dickey-Fuller (ADF) unit root tests on the individual firms.

2. The null hypothesis is that of a unit root.

Table 2 shows whether the cointegration relationship exists between individual stock prices and EPS. We use the Engle-Granger cointegration tests by individual firm and the result indicates most of firms have no cointegration relation between stock prices and EPS, because only 10 out of the 75 firms exhibit cointegration relation.

Table 2. The result of the Engle-Granger co-integration test by individual firm

-2.1352	-4.1232***	-2.3457	-1.6409	-1.7962	-0.3790	-1.1552
-1.4788	-1.0110	-1.7365	-2.7165	-0.7472	-4.2550***	-2.6526
-1.4796	-2.9099	-3.0625	-2.6697	-2.7878	-2.4145	-4.4687***
-1.3828	-1.3386	-2.0281	-1.5094	-2.8007	-1.5659	-2.6748
-2.6862	-1.8174	-2.2105	-2.9058	-3.3016	-4.1645***	-4.0628***
-5.7381***	-4.5702***	-4.4017***	-3.2660	-2.5276	-3.6237***	-2.1736
-2.1890	-3.3585	-1.0211	-2.9260	-1.8565	-3.2974	-1.4047
-1.5935	-2.1504	-2.2825	-1.8431	-3.4682	-2.5571	-2.9379
-2.7128	-2.2544	-2.3079	-2.7134	0.4670	-1.2247	-2.9992
-2.6713	-2.6455	-2.7383	-2.7182	-3.4539	-3.1034	
-1.7342	-0.7966	-4.4137***	-3.1182	-2.3428	-2.7816	

Note: *** indicates the significance by 1% using ADF test.

4.2 Results from the panel data

The panel unit root tests are used to examine the stationary properties of the data. The critical values based on Monte Carlo simulations[1] using 20,000 replications for each test are given in Table 3 and Table 4. In general, there are substantial size distortions with cross-correlated errors in using panel unit test statistics. However, using the bootstrap method can result in a decrease of size distortions with cross-correlated errors (Maddala and Wu, 1999).The result finds that IPS and MW tests all fail to reject the null hypothesis that unit root exists for stock prices and EPS. The Hadri (2001) test rejects the null of stationary stock prices and EPS. We can find that the stock prices and EPS series are non-stationary for all categories of firms.

Table 3. Panel Unit root Tests resulting on Stock prices

Method \ Category	All firms statistics	Low-Growth statistics	Medium- Growth statistics	High-Growth statistics
IPS	-0.961	-0.165	-0.170	-1.499
MW	177.373	33.311	83.758	60.304

[1] We use data-generating process (DGP) for a dynamic panel containing group and time-specific effects. In the simulation, error term is generated randomly from $N(0,1)$ and allowed contemporaneous correlation. The procedure is combined the p-value to get χ^2 test statistic and used bootstrap method for obtaining the critical values, to account for the correlations among test statistics for the individual cross-section units.

Hadri (homo)	13.775***	7.579**	9.402**	6.388**
Hadri (het)	11.632***	6.515**	8.328**	4.975*

Notes: 1. ***, **, and * indicate significance at the 1%, 5% and 10%.

2. The test statistics of IPS and MW's critical values are based on bootstrap using 20,000 replications.

3. The test statistics of Hadri's critical values are based on Monte Carlo Simulations using 20,000 replications.

Table 4. Panel Unit root Tests resulting on EPS

Category / Method	All firms statistics	Low-Growth statistics	Medium- Growth statistics	High-Growth statistics
IPS	-12.037	-6.221	-8.907	-5.280
MW	576.475	150.420	258.146	107.827
Hadri (homo)	10.368***	7.894***	5.042**	5.751***
Hadri (het)	11.406***	7.677***	7.457***	4.577***

Notes: 1. ***, **, and * indicate significance at the 1%, 5% and 10%.

2. The test statistics of IPS and MW's critical values are based on bootstrap using 20,000 replications.

3. The test statistics of Hadri's critical values are based on Monte Carlo Simulations using 20,000 replications.

The next step will be to examine whether a long-run relationship exists between stock prices and EPS. The drawback of traditional cointegration is that they fail to consider the information across firms. Recently developed techniques allow us to deal with non-stationary data in a heterogeneous panel, which yields actual benefits by exploiting data from cross-section. We used panel data to apply to the panel cointegration test of Pedroni (1995, 1999, 2000) to examine the cointegration relationship between stock prices and EPS.

Table 5 summarizes the results of cointegration analysis among the two variables using Pedroni statistics. We find that the Low-growth, Medium-growth, High-growth firms and all firms reject the null hypothesis at the 1% significant level. It means that stock prices and EPS have a long-run relationship under stock prices and EPS has dissimilar growth rate of operating revenue firms.

Table 5. Pedroni (1995; 1999; 2000) cointegration tests for heterogeneous panels.

Category / Test	All firms statistics	Low-Growth Statistics	Medium- Growth statistics	High-Growth Statistics
Panel statistics				
Panel-*v*	10.73920***	6.59650***	8.07610***	3.81073***
Panel-*p*	-11.13356***	-7.57748***	-7.83746***	-3.99325***
Panel-*t*	-12.24555***	-7.40683***	-8.61554***	-5.08167***
Panel-*adf*	-11.31574***	-7.29403***	-7.50430***	-4.87279***

Group statistics				
Group-*p*	-9.50380***	-6.01785***	-6.09688***	-4.35621***
Group-*t*	-13.56820***	-7.87467***	-8.85641***	-6.72365***
Group-*adf*	-12.79641***	-7.86264***	-7.94958***	-6.46776***

Notes: 1. *** indicates significance levels at 1%.

2. The null hypothesis is no cointegration.

4.3 ERC Estimation of Panel Cointegrated Regression

We will estimate ERCs by using DOLS estimated from Kao and Chiang (2000) test and the FMOLS estimated from Pedroni (2001) test. The panel cointegration coefficients stand for the extent that stock prices reflect EPS. Table 6 indicates that OLS estimators are in the range 0.31-0.58, the adjusted OLS estimators are in the range 0.37-0.72, the DOLS estimators are in the range 0.60-0.89, and the FMOLS estimators are in the range 0.45-0.97. The DOLS and FMOLS estimators are 0.74 and 0.75 for all firms, we can get that if the EPS increase, the stock price seems to increase by a proportion in 0.74-0.75. However, FMOLS from Pedroni (2001) will be more promising than DOLS from Kao and Chiang (2000). That is based on that Pedroni (2001) proposed FMOLS estimator allows more flexible alternative hypothesis and it provides a consistent test of a common value for the cointegration vector under the null hypothesis against values of the cointegration vector that need not be common under the alternative hypothesis. DOLS proposed from Kao and Chiang belongs to the within-dimension estimator and it does not deal with the alternative hypothesis of heterogeneous coefficients in this sense. We can find that the larger the firms' growth rates, the lower the cointegration coefficients for DOLS and FMOLS estimators. It is similar to the Differential Information Hypothesis proposed by Atiase (1985), who indicated that the lager the firms' dimensions, the smaller the variation of stock prices. Investors may collect information on the firms normally for high growth firms and after the quarter earnings are announced, (the investors' reaction may be rather slight of high growth firms than of the low growth firms).

Table 6. Kao and Chiang (2000) & Pedroni (2000) Panel cointegration estimation

	OLS	**Adjusted OLS**	**DOLS**	**FMOLS**
All firms:				
β	0.41	0.50	0.74	0.75
$t-value$	28.62***	26.16***	35.04***	-20.39***
High-Growth firms:				
β	0.31	0.37	0.60	0.45
$t-value$	16.38***	13.32***	19.46***	-23.66***
Medium-Growth firms:				
β	0.43	0.52	0.692	0.79
$t-value$	19.82***	18.90***	22.54***	-10.64***

Low-Growth firms:				
β	0.58	0.72	0.89	0.97
$t-value$	15.04***	15.71***	17.32***	-2.00**

Note: *** indicates significance levels at 1%.

5. Conclusion

This study investigated the relationship between the stock prices and EPS of the electronic firms listed on the Taiwan Stock exchange (TSEC). The panel based tests suggest that stock prices are cointegrated with EPS, while the individual stock prices do not show cointegration with EPS. We can make a primary conclusion that stock prices moves with EPS in the long-run, but not necessary at the same rate. Furthermore, there exists an inverse relation between the growth rate of operating revenue and the degree of EPS impact on stock prices. Finally, we found evidence that EPS could impact stock prices, and the "Earnings Information Content" exists in the listed electronic industries in Taiwan. It could provide investors or securities analysts a method to predict the variation for stock prices under long-run strategy of investment.

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