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股價泡沫會影響盈餘預測股價報酬嗎?以 1990 年代 S&P 股價泡沫為例

Do Stock Price Bubbles Affect the Predictability of Stock Returns Through Earnings? Evidence From the 1990s S&P Bubble Period

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摘要

資產價格泡沫使得其市場價值脫離了基本面，股票價格與基本面在投機的 1990 年代後期呈現著顯著分歧。許多研究發現在 1990 年代以前股票報酬是可以被預測的，本文想要探討股票價格泡沫是否會影響盈餘預測股票報酬。Phillips et al. (2011) 所提出來的往前反覆迴歸方法可以偵測到資產價格泡沫起始及結束點。Goyal & Welch (2003)、Lettau & Ludvigson (2005) 與 Ang & Bekaert (2007) 雖提出在 1990 年代股價報酬無法被預測，但是他們的 1990 年代樣本區間並不一致，本文採用 Phillips et al. (2011) 可以準確的指出 1990 年代的 S&P 股價泡沫區間。本文進一步發現股價泡沫確實會影響盈餘預測股票報酬，盈餘變數只有在非泡沫時期才能預測股價報酬。投資者了解到泡沫的出現與否，確實會影響到基本面對股價報酬的預測能力，可以調整其投資策略從事資產配置。

關鍵詞：泡沫、預測

Abstract

Asset price bubble means that the market value diverges from fundamental value and stock market price diverged significantly from the fundamental during the speculative period of the late 1990s. The majority of studies establishing strong evidence of the predictability of stock returns use data from before or up to the early 1990s. I hypothesized that bubbles will affect predictability of stock returns through earnings. The methodology presented by Phillips et al. (2011) is not only an ex ante econometric methodology but also one of the first attempts to date the origin and conclusion of a bubble period. This study clearly identifies the beginning and ending of the 1990s S&P bubble period. Goyal & Welch (2003), Lettau & Ludvigson (2005), and Ang & Bekaert (2007) all argued that stock returns could not be predicted when the sample includes the 1990s; however, their

1990s sample periods were not consistent and they did not indicate the beginning and ending of the 1990s stock bubble period. I present evidence that stock price bubbles affect the predictability of stock returns through earnings, and that this predictability only exists in the periods in which no bubbles are present, the pre-bubble and post-bubble periods. The results are helpful for investors seeking to identify stock bubble periods, realizing the influence and consequence of stock bubbles, and performing their assets allocations.

Keywords: Bubble, Predictability

1. INTRODUCTION

If accounting earnings are idiosyncratic and diversifiable, then they are unimportant from an asset-pricing perspective, because only systematic or aggregate risk should be priced (Vuolteenaho, 2002). Conversely, if accounting earnings data reflect the activity of a business and help estimate the fundamental value of a company, earnings help forecast future stock prices. It is worthwhile for investors to explore whether earnings provide information that will be reflected in stock prices.

Whether earnings data are helpful in explaining stock returns is inconclusive. Whereas Campbell & Shiller (1988), Lamont (1998), Lee et al. (1999), and Sadka (2007) reported that earnings information is useful for explaining stock returns, Fama & French (1988), Lee (1996), Kothari et al. (2006), Ang & Bekaert (2007), and Pan (2007) argued that earnings are not useful in predicting future stock returns. In this study, I attempt to determine a controlling variable that will be helpful to address the puzzle of the predictability of stock returns through changes in earnings.

Over the past century, American economic and financial activities have transformed in various fundamental ways. These changes have affected the financial market as much as any other part of the economy. During the 1990s, led by dot com stocks, the United States stock market experienced a spectacular rise in all major indices. The majority of studies establishing strong evidence of the predictability of stock returns use data from before or up to the early 1990s. However, they also argue that stock returns are not predictable when samples include the 1990s.

For example, Goyal & Welch (2003) observed that the dividend-price ratio exhibited forecasting power regarding equity premiums in the 1926-1990 period. However, when the sample was extended to 2002, stock returns were not predictable. Lettau & Ludvigson (2005) showed that the dividend-price ratio has little power to forecast aggregate stock market returns from 1 to 6 years in the 1948-2001 sample period. They argued that the extraordinary increase in stock prices in the late 1990s substantially weakened the statistical evidence for predictability using the dividend-price ratio. Ang & Bekaert (2007) indicated that stock return predictability by the earnings-price ratio is considerably strong in the 1935-1990 period. However, there is no evidence of predictability in the 1952-2001 period. In summary, the aforementioned studies have indicated stock return predictability by the dividend-price ratio or earnings-price ratio when the 1990s were omitted.

Evidence has also shown that stock price bubbles could be a source for the break in the relationship between stock prices and fundamental. For example, Andrews & Kim (2003) reported that, in the late 1990s, there was a shift in the errors of the system from stationary to nonstationary, which implies a breakdown in the historical relationship between price and value. Lee et al. (1999) showed that, historically, market value and accounting-based measures of intrinsic value have tended to converge over time, for example, from 1979 to 1996. However, Curtis (2005) split this sample into the period of Lee et al. (1999), January 1979 to June 1996, and the subsequent period, July 1996 to October 2002, and observed that market price diverged significantly from the fundamental value when the speculative period of the late 1990s was included. These evidences show that high stock prices relative to fundamental in the 1990s could play a critical role in forecasting stock return.

By considering the evidence against the predictability of stock returns and the breakdown of the relationships between stock price and fundamental when including the 1990s in the sample, I hypothesized that bubbles affect the predictability of stock returns through changes in earnings. The methodology presented by Diba & Grossman (1988a) is considerably popular in testing for bubbles. However, Evans (1991) criticized that the methodologies presented by Diba & Grossman (1988a) incorrectly lead to the conclusion that speculative rational bubbles do not exist when periodically collapsing rational bubbles are present. Phillips et al. (2011) suggested using forward recursive regression techniques to identify the origin and conclusion of periodically collapsing bubbles.

Two steps can be used to examine my hypothesis. First, I adopted the forward recursive methodology presented by Phillips et al. (2011) and detected periodically collapsing bubbles for stock prices and earnings series over the entire sample period. If a periodically collapsing bubble was detected, then I dated the beginning and end of the bubble period and divided the full sample into sub-periods with and without bubbles. Second, I ran Granger causality tests to determine whether past changes in earnings could predict current stock returns over the periods with and without bubbles.

I used monthly Standard & Poor (S&P) 500 data from February 1973 to June 2007 and identified a periodically collapsing bubble in the S&P index, beginning in November 1996 and ending in April 2002. November 1996 was the beginning of the 1990s S&P stock price bubble, and it was also one month before Alan Greenspan, the former chairman of the Federal Reserve Board, delivered his famous irrational exuberance speech. I did not observe periodically collapsing bubbles in earnings series for the full sample.

I observed that changes in earnings do not have predictability regarding stock returns over the full sample period from February 1973 to June 2007. However, after I controlled for the bubble effect, the evidence showed that stock price changes respond to earnings changes in the pre-bubble period, February 1973 to October 1996, and in the post-bubble period, May 2002 to June 2007. Additionally, the no-causality result in the bubble period was the same in the full sample period.

There have been no empirical studies that identify the beginning and ending of the 1990 S&P bubble period and further investigate the relationship between change in earnings and the predictability of stock returns under the bubble effect. The current study attempts to examine this relationship empirically and supplement the existing literature.

This study provides two major contributions: First, it clearly identifies the beginning and ending of the 1990s S&P bubble period. Goyal & Welch (2003), Lettau & Ludvigson (2005), and Ang & Bekaert (2007) have argued that stock returns were not predictable when the sample includes the 1990s; however, their 1990s sample periods were not consistent and they did not indicate the beginning and end of the 1990s stock bubble period; Second, it presents evidence that stock price bubbles affect the predictability of stock returns through changes in earnings, and that this predictability only exists in the period with no bubbles, in both the pre-bubble and post-bubble periods.

The remainder of this paper is organized as follows. In Section 2, I review periodically collapsing bubbles and outline forward recursive regression tests for detecting bubble periods and the Granger causality tests for stock return predictability. In Section 3, I describe the data. In Section 4, I present the empirical results. The final section provides a conclusion.

2. RESEARCH METHOD

2.1. Periodically Collapsing Bubbles

The standard present value model of stock prices can be expressed using Equation (1):

$$P_t = \frac{1}{1+r} E_t(P_{t+1} + D_{t+1}) \quad (1)$$

The real stock price should equal the present discounted value of the next period's expected real stock price, in addition to the real dividend payment. P_t

and D_t are the real stock prices and dividends, respectively, and $(1+r)^{-1}$ is the constant discount factor. $E_t(\cdot)$ is the market's expectation based on information known at the beginning of period *t*.

Under transversality conditions, Equation (2), the stock price can be derived by successive

$$\lim_{i\to\infty}\frac{1}{(1+r)^i}E_t(P_{t+i})=0 \quad (2)$$

Adding forward substitutions into Equation (1) yields Equation (2). The stock price P_t is equal to fundamental value F_t, and it equates a stock's price to the present discounted value of expected future dividends payments.

$$F_t=\sum_{j=1}^{\infty}\frac{1}{(1+r)^j}E_t(D_{t+j}) \quad (3)$$

Conversely, if Equation (2) fails to hold, then the real stock price can be considered the sum of fundamental value F_t and a rational bubble B_t:

$$P_t=F_t+B_t \quad (4)$$

where the bubble component satisfies Equation (5):

$$B_t=\frac{1}{1+r}E_t(B_{t+1}) \quad (5)$$

If no bubbles are present, and dividends are I(1), then stock prices are I(1), according to Equation (3). Furthermore, P_t and D_t are theoretically cointegrated with cointegrating vector $(1,r^{-1})$. The difference $P_t-r^{-1}D_t$ is equivalent to a linear combination of the variables ΔD_{t+1} and can be expressed using Equation (6).

$$P_t - r^{-1}D_t = (1+r)r^{-1}\sum_{j=1}^{\infty}\frac{1}{(1+r)^j}E_t(\Delta D_{t+j}) \qquad (6)$$

Because Equation (5) implies explosive behavior in B_t, P_t is also explosive if bubbles are present, regardless of whether D_t is stationary or nonstationary. Therefore, the linear combination $P_t - r^{-1}D_t$ is not stationary, but contains an explosive component, and ΔP_t is also explosive. Diba & Grossman (1988a) presented their methodology for testing for bubbles based on this theory. They performed the following tests: (a) According to the unit root test for the stationarity of P_t, D_t, ΔP_t, and ΔD_t, if P_t and D_t are nonstationary, and ΔP_t and ΔD_t are stationary, then no bubbles are present in P_t. (b) According to a test for the cointegration of P_t and D_t, if ΔD_t is stationary and P_t and D_t are cointegrated, then ΔP_t must be stationary, proving that no bubbles are present.

However, Evans (1991) criticized that the methodologies presented by Diba & Grossman (1988a) incorrectly lead to the conclusion that speculative rational bubbles do not exist when periodically collapsing rational bubbles are present. Based on the work of Blanchard (1979), Blanchard & Waston (1982), and Diba & Grossman (1988b), Evans (1991) proposed a model to simulate periodically collapsing bubbles and showed that standard unit root tests and cointegration tests had little power to detect this type of bubble. Evans (1991) suggested the following model for a bubble process B_t that collapses periodically:

$$B_{t+1} = (1+r)B_t u_{t+1}, \quad \text{if } B_t \le \alpha \qquad (7a)$$

$$B_{t+1} = [\zeta + \frac{(1+r)}{\pi}\theta_{t+1}(B_t - \frac{\zeta}{(1+r)})]u_{t+1}, \quad \text{if } B_t > \alpha \qquad (7b)$$

Here, ζ and α are positive parameters with $0 < \zeta < (1+r)\alpha$, and π denotes a probability. The term u_{t+1} is an exogenous independently and identically distributed positive random variable with $E_t u_{t+1}$ = 1, and θ_{t+1} is an exogenous independently and identically distributed Bernoulli process that takes the value 1 with a probability of π and 0 with a probability of 1-π, where $0 < \pi \le 1$. When the bubble size is smaller than α, the bubble grows at a mean rate of $1+r$. When the bubble size is greater than α, the bubble grows at a faster rate of $(1+r)\pi^{-1}$, as long as the eruption continues, with a probability of π, but the bubble may collapse with a probability of 1-π per period. When the bubble collapses, it falls to the positive mean value of ζ, and the process begins again.

Evans (1991) showed the low power of standard unit root and cointegration tests by conducting a simulation. The results of the test depend heavily on π, the probability per period that the bubble does not collapse. When π approaches 1, the Equation (7) converges to $B_{t+1}=(1+r)B_t u_{t+1}$, and the results are similar to those of Diba & Grossman (1988b). The periodically collapsing bubbles can also be detected. However, for $\pi \le 0.95$, periodically collapsing bubbles behave much more similar to I(1) or even stationary processes than to an explosive process. Hence, Evans (1991) showed that periodically collapsing bubbles are not detectable by using the standard unit root test.

2.2. Forward Recursive Regression Tests for Detecting Bubble Periods

For the unit root test procedure to be powerful in detecting periodically collapsing bubbles, Phillips et al. (2011) propose a recursive test procedure for testing explosive behavior, stamping the origination and collapse of economic exuberance, and providing valid confidence intervals for explosive growth rates. The method involves the recursive implementation of a right-side unit root test and a sup test, both of which are easy to use in practical applications, and some new limit theory for mildly explosive processes. The test procedure is shown to have discriminatory power in detecting periodically collapsing bubbles, thereby overcoming a weakness in earlier applications of unit root tests for economic bubbles. An empirical application to the Nasdaq stock price index in the 1990s provides confirmation of explosiveness and date stamps the origination of financial exuberance to mid-1995.

For each time series X_t, Phillips et al. (2011) applied the augmented Dickey-Fuller (ADF) test for a unit root against the alternative of an explosive root (right-tailed). In other words, they followed autoregressive specification by lease squares for a given value of the lag parameter J .

$$X_t = \mu_X + \delta X_{t-1} + \sum_{j=1}^{J} \phi_j \Delta X_{t-j} + \varepsilon_{x,t} \tag{8}$$

where $\varepsilon_{X,t}$ is an independent and normal distribution random variable with mean 0 and variance σ_X^2, the unit root null hypothesis is H_0: $\delta = 1$, and the right-tailed alternative hypothesis is H_1: $\delta > 1$.

In forward recursive regressions, Equation (8) is estimated repeatedly, using subsets of the sample data incremented by one observation at each pass. If the first regression involves n_{r0}=[nr_0] observations, for fractions r_0 of the total sample, where [ ] signifies the integer part of its argument, subsequent regressions employ this originating data set supplemented by successive observations, yielding a sample of size n_r=[nr] for $r_0 \le r \le 1$. Denote the corresponding t statistic by using ADF_r, and ADF_1 corresponds to the full sample. To locate the beginning and ending of bubbles, match the time series of ADF_r with $r \in [r_0,1]$ against the right-tailed critical values from the asymptotic distribution of the standard Dickey-Fuller t statistic.

The most bubble detecting methodologies are all ex post econometric techniques. Only when the full cycle of exuberance and collapse is complete can a financial bubble be identified. It means that bubbles can be identified only in hindsight after a market correction. Phillips et al. (2011) argues that developing a truly anticipative ex ante econometric methodology will be more challenging and it might be used as a warning alert system of changes in behavior or system responses. During the 1990s Nasdaq bubble, the Federal Reserve Chairman Alan Greenspan articulated this type of uncertainty as a loaded question in his famous 1996 dinner speech with:

“How do we know when irrational exuberance has unduly escalated asset values?’’

Greenspan’s remark underscores the fact that we usually don’t know when an asset price bubble begins and, even after a collapse, academic disputes arise over whether a bubble has actually occurred. The methodology presented by Phillips et al. (2011) is not only an ex ante econometric methodology but also one of the first attempts to date the origin and conclusion of a bubble period.

2.3. Granger Causality Test

The traditional linear Granger (1969) test is a well-known test for bivariate causality and is usually constructed in the context of a reduced-form bivariate vector autoregression (VAR). The following regression equations were used to test causality in this study:

$$\Delta p_t = c_p + \sum_{i=1}^{k} a_{1i}\Delta p_{t-i} + \sum_{i=1}^{k} a_{2i}\Delta e_{t-i} + \varepsilon_{1t} \qquad (9a)$$

$$\Delta e_t = c_e + \sum_{i=1}^{k} b_{1i}\Delta p_{t-i} + \sum_{i=1}^{k} b_{2i}\Delta e_{t-i} + \varepsilon_{2t} \qquad (9b)$$

where p_t and e_t represent stock prices and earnings in logarithms, and the error terms ε_{1t} and ε_{2t} are separate i.i.d. processes with zero mean and constant variance. The null hypothesis that changes in earnings do not Granger cause stock market returns is tested using $H_0: a_{21} = a_{22} = ... = a_{2k} = 0$ in (9a). If cointegration exists between p_t and e_t, then an error correction term (ECT) is required in testing Granger causality, as follows:

$$\Delta p_t = c_p + \alpha_p z_{t-1} + \sum_{i=1}^{k} a_{1i}\Delta p_{t-i} + \sum_{i=1}^{k} a_{2i}\Delta e_{t-i} + \varepsilon_{1t} \qquad (10a)$$

$$\Delta e_t = c_e + \alpha_e z_{t-1} + \sum_{i=1}^{k} b_{1i}\Delta p_{t-i} + \sum_{i=1}^{k} b_{2i}\Delta e_{t-i} + \varepsilon_{2t} \qquad (10b)$$

where α_p and α_e denote speeds of adjustment, z_t represents the deviation from the long-run relationship between p_t and e_t, and the long-run cointegrating relationship is $z_{t-1} = p_{t-1} + \beta e_{t-1} + c$. The null hypothesis that changes in earnings do not Granger cause stock market returns in this case is tested using $H_0: \alpha_p = 0$ and $a_{21} = a_{22} = ...a_{2k} = 0$ in (10a).

3. DATA

This study used monthly data on U.S. S&P composite stock prices and earnings extracted from an update of data shown in Shiller (2005). The stock prices are monthly averages of daily closing prices for the S&P Composite Stock Price Index. The earnings are computed from four-quarter tools for the quarter with linear interpolation of monthly figures. Nominal stock prices and earnings were deflated using the consumer price index to obtain real stock prices and earnings. Phillips et al. (2011) detected periodically collapsing bubbles in the NASDAQ market in a full sample period from February 1973 to June 2005, and observed that bubbles originated in June 1995 and concluded in July 2001. To allow comparison between the S&P stock bubble period with the NASDAQ stock bubble period, I adopted the sample period from February 1973 and extended the final sample to June 2007. The sample consists of 413 monthly observations.[1]

4. EMPIRICAL RESULTS

4.1. Dating the Beginning and Ending of the S&P 1990s Bubble Period

Figure 1 represents the time series of the ADF_r statistic for the logarithmic real stock prices and earnings from June 1976 to June 2007. The ADF_r statistic was obtained using forward recursive regressions. The optimal lag length was selected using Schwarz's (1978) information criterion (SIC). The full sample period was from February 1973 to June 2007, comprising 413 observations. The

[1] This study does not incorporate more recent data in order to more clearly highlight the 1990s S&P stock bubbles effect on predictability of stock return and at the same time not shift the focus of the paper from the analyses of whether earnings can predict returns absent bubbles to the confounding effects from the Great Recession and the strong bull market following June 2007.

initial start-up sample for the regression covered the period from February 1973 to June 1976 with 41 observations (where r_0 = 0.1, 10% of the full sample). The 5% asymptotic critical value was -0.08, obtained from Fuller (1996, Table 10.A.2).

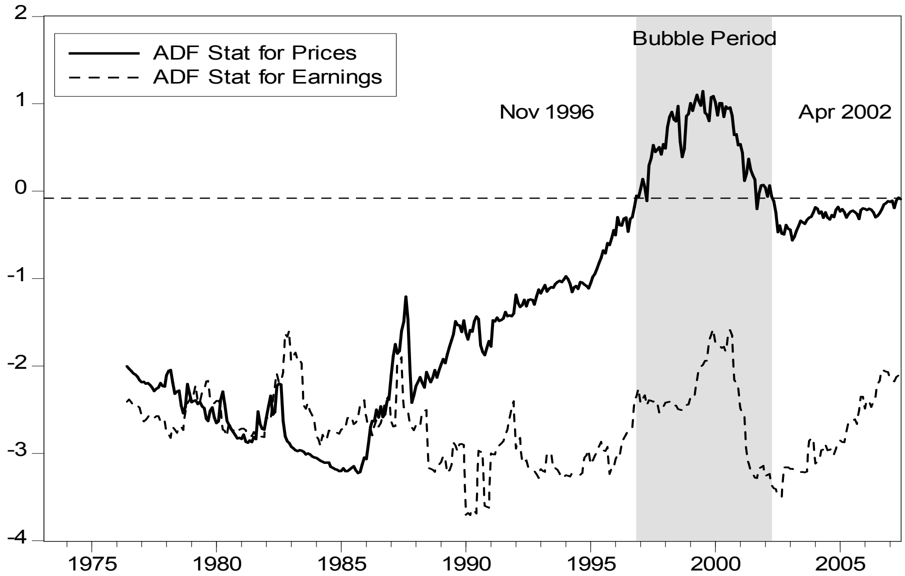

Figure 1. Time Series Plot of ADF_r Statistic for the Stock Prices and Earnings
This figure represents the time series of the ADF_r statistic for the logarithmic real stock price and earnings from June 1976 to June 2007. The ADF_r statistic is obtained from the forward recursive regressions. The full sample period is from February 1973 to June 2007 with 413 observations. The initial start-up sample for the regression covers the period from February 1973 to June 1976 with 41 observations (where r_0 = 0.1, 10 percent of the full sample). The 5 percent asymptotic critical value is -0.08 obtained from Fuller (1996, Table 10.A.2). The periodically collapsing stock bubble began from November 1996 and ended in April 2002. I cannot find any periodically collapsing bubble in earning series.

Data source: this study

I identified that S&P periodically collapsing bubbles began from November 1996 and ended in April 2002. November 1996 was the beginning of the S&P bubble, and it was also one month before Alan Greenspan, the former chairman of the Federal Reserve Board, delivered his famous irrational exuberance speech. When Greenspan addressed the irrational exuberance of investors on December 5, 1996, the S&P 500 index was only at 744 and the NASDAQ index was only at

1300. Periodically collapsing bubbles were not observed for earnings series over the full sample period.

Phillips et al. (2011) detected a NASDAQ bubble for the sample period from February 1973 to June 2005. The beginning and ending of the NASDAQ bubble period were June 1995 and July 2001, respectively. The beginning date of the S&P stock price bubble, November 1996, was later than the beginning date of the NASDAQ stock price bubble, June 1995. The end date of the S&P stock price bubble, April 2002, was also later than the end of the NASDAQ stock price bubble, July 2001. The S&P 500 index rose to 1527 on March 24, 2000 and the NASDAQ index rose to 5049 on March 10, 2000, before they fell. The S&P index doubled from the day Greenspan addressed irrational exuberance to the day touched the highest price; however, the NASDAQ index increased almost 4-fold over the same period, suggesting that the NASDAQ bubble was larger than the S&P bubble. Conversely, the period of the S&P bubble continued for 66 months, which is shorter than the period of the NASDAQ bubble (74 months).

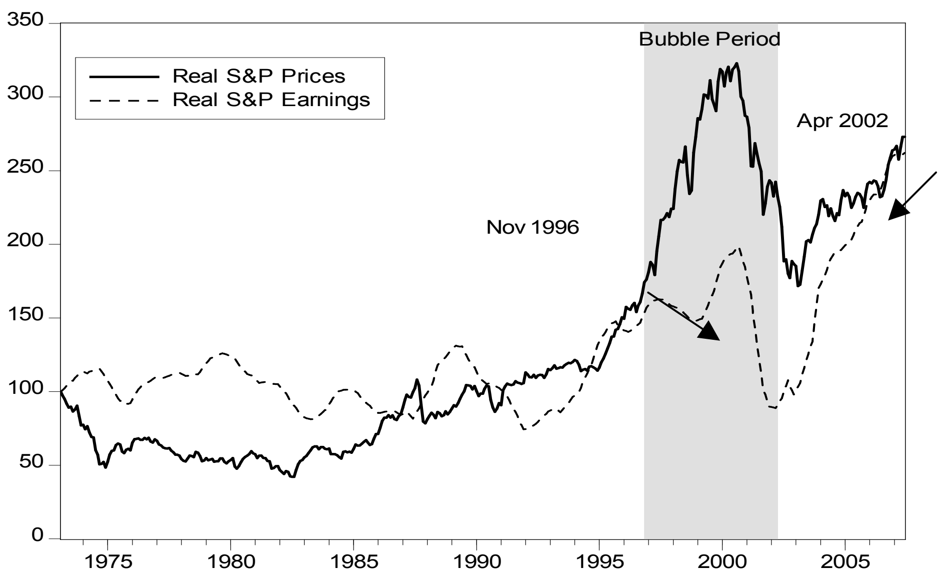

Fig 2. Time Series Plots of Real S&P Prices and Earnings

This figure represents the time series of real stock prices and earnings from February 1973 to June 2007. The stock price bubble began from November 1996 and ended in April 2002. Both series are normalized to 100 in the beginning of the sample.

Data source: this study

Figure 2 shows the time series of real stock prices and earnings from February 1973 to June 2007. Both series were normalized to 100 at the beginning of the sample. I divided the full sample period, February 1973 to June 2007, into three sub-periods. The first sub-period, from February 1973 to October 1996, is called the pre-bubble period; the second sub-period, from November 1996 to April 2002, is called the bubble period; and the third sub-period, from May 2002 to June 2007, is called post-bubble period. In the pre-bubble period, although the gap between the stock prices and earnings was not to close to the same line, stock prices and earnings did not deviate from each other. In the bubble period, stock prices increased sharply until the peak of the bubble and then fell sharply. In the post-bubble period, earnings series rose sharply, approached stock price series, and finally reached stock price series. Stock price and earnings series were more closely related in the pre- and post-bubble periods than in the bubble period.

Table 1. Unit Root Tests for Full Sample Period and Sub-Periods

Period	Variables	ADF statistics	PP statistics
Full Sample	p_t	-0.0913	-0.0863
	e_t	-2.0386	-1.1154
	Δp_t	-12.8612**	-15.5597**
	Δe_t	-5.3346**	-5.4314**
Pre-Bubble	p_t	-0.1817	-0.1392
	e_t	-2.3044	-1.7412
	Δp_t	-10.4550**	-12.5392**
	Δe_t	-4.3378**	-4.3865**
Bubble	p_t	-2.3605	-2.4635
	e_t	-2.4234	-0.3479
	Δp_t	-5.7353**	-6.7343**
	Δe_t	-3.6427**	-4.3381**
Post-Bubble	p_t	-1.0646	-0.7493
	e_t	-1.7132	-2.0074
	Δp_t	-4.4655**	-5.8266**
	Δe_t	-3.8886**	-3.7406**

This table reports tests for stationarity in log prices p_t and log earnings e_t for levels and changes in levels. Δp_t is the changes in log prices and Δe_t is the changes in log earnings. In Augmented Dickey-Fuller (ADF) test, the optimal lags are chosen by SIC criterion. In Phillips-Perron (PP) test, the zero frequency spectrum term using a kernel sum-of-covariances estimator with Bartlett weights is estimated. Unit root tests include intercept of the null. The critical values corresponding to p -values of 0.05 are -2.87 for full sample and pre-bubble period, and are -2.91 for bubble and post-bubble period. Full Sample period is February 1973-June 2007, Pre-Bubble period is February 1973- Oct. 1996, Bubble period is November 1996-April 2002, and Post-Bubble period is May 2002-June 2007.

** Statistically significant at 5 % level of significance

Data source: this study

4.2. The Granger Causality Results

I hypothesized that bubbles affect the predictability of changes in earnings to stock returns. To test the predictability of this hypothesis, I conducted Granger causality tests to determine whether past earnings data could predict current the stock price in the periods with and without bubbles. The full sample and bubble periods were the periods with bubbles, and the pre- and post-bubble periods were the periods without bubbles.

When stock prices and earnings are not stationary series, cointegration must be determined before conducting Granger causality tests. I performed VAR (Vector AutoRegression) model under no cointegration and VECM (Vector Error Correction Model) under cointegration conditions to conduct the Granger causality test. Table 1 lists the results of augmented Dicky-Fuller and Phillips-Perron unit root tests for two level variables, log stock price and earnings (p_t and e_t), and two differenced variables, the changes in log prices and the changes in log earnings (Δp_t and Δe_t ; Dickey & Fuller, 1979; Phillips & Perron, 1988). The estimated results show that I failed to reject the unit root for p_t and e_t at a significance level of .05. The null hypothesis that Δp_t and Δe_t contain the unit root was rejected at a significance level of .05. The series of the natural log of stock prices and earnings were all I(1), and the change in log stock prices and change in log earnings were I(0) in the full sample and all sub-periods.

Table 2. Cointegration Test for Full Sample Period and Sub-Periods

Period	Null	λ_{Trace}	λ_{MAX}
Full Sample	r = 0	13.8588	12.3559
	r≦ 1	1.5030	1.5030
Pre-Bubble	r = 0	11.2920	10.5612
	r≦ 1	0.7308	0.7308
Bubble	r = 0	20.0208	11.8400
	r≦ 1	8.1807	8.1807
Post-Bubble	r = 0	30.8961**	24.7012**
	r≦ 1	6.1949	6.1949

This table reports the Johansen test for cointegrating vectors for log prices p_t and log earnings e_t. r = 0 tests the null hypothesis that the number of cointegrating vector is zero, and r≦ 1 tests the null hypothesis that the number of cointegrating vector is at most equal to one. λ_{Trace} is Trace Statistics and λ_{MAX} is Max-Eigenvalue Statistics. The critical values corresponding to p -values of 0.05 under Null r = 0 are 20.26 for λ_{Trace} and 15.89 for λ_{MAX}. The critical values corresponding to p -values of 0.05 under Null r ≦ 1 are 9.16 for λ_{Trace} and λ_{MAX}.

** Statistically significant at 5 % level of significance

Data source: this study

To explore the effects of possible cointegration among the VAR variables, I conducted VAR-based cointegration tests by using the methodology developed in Johansen (1988) and Johansen & Juselius (1990). I chose the optimal lag length for the VAR-based cointegration test by using the SIC criterion and ensuring that residuals of VAR acted as a white noise process. Table 2 shows that the trace statistics and max eigenvalue statistics identified one cointegrating vector between p_t and e_t, only in the post-bubble period, at a significance level of .05, but rejected any cointegration between p_t and e_t in the full sample, the pre-bubble and bubble periods. Hence, I conducted VECM analysis in the post-bubble period and VAR analysis in the full sample and the pre-bubble and bubble periods to test the Causality between Δp_t and Δe_t.

Panel A of Table 3 shows the VAR of the changes in log prices (Δp_t) and the changes in log earnings (Δe_t) against their lags Δp_{t-i} (the i -th lagged change in log price) and Δe_{t-i} (the i -th lagged change in log earnings) for the full sample, and the pre-bubble and bubble periods, because log prices and earnings were not cointegrated in these periods. The optimal lag (k) was 1 for the full sample and the pre-bubble and bubble periods according to the SIC criterion. The t statistic is reported in parentheses immediately below the parameter estimate. The coefficients of the lagged changes in log earnings, Δe_{t-i} , were not significant in the Δp_t equation in the full sample and bubble periods, meaning that the short-run predictability of stock returns through changes in earnings is not supported in the periods with bubbles. However, the coefficient of the lagged changes in log earnings, Δe_{t-i} , was significant in the Δp_t equation in the pre-bubble period. I observed strong evidence of the short-run predictability of stock returns through changes in earnings over the period without bubbles.

Panel B of Table 3 shows the VECM of Δp_t and Δe_t against their error correction terms, α_p and α_e , and their lags, Δp_{t-i} and Δe_{t-i} , for post-bubble period, because log prices and earnings were cointegrated. The optimal lag (k) was 2 for the post-bubble period, according to the SIC criterion. The coefficient of the second lagged changes in log earnings, Δe_{t-i} , was significant in the Δp_t equation in the post-bubble period. It showed strong evidence of the short-run predictability of stock returns through changes in earnings over the period without bubbles.

Table 3. VAR for Full Sample, Pre-Bubble and Bubble Periods and VECM for Post-Bubble Period

Panel A. VAR for Full Sample, Pre-Bubble and Bubble periods

$$\Delta p_t = c_p + \sum_{i=1}^{k} a_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} a_{2i} \Delta e_{t-i} + \varepsilon_{1t}$$

$$\Delta e_t = c_e + \sum_{i=1}^{k} b_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} b_{2i} \Delta e_{t-i} + \varepsilon_{2t}$$

Period	Bubble	Lags	Δp_t	Δe_t
Full Sample	Yes	Δp_{t-1}	0.2591***	0.0027
			[5.4292]	[0.1931]
		Δe_{t-1}	-0.0360	0.8695***
			[-0.4319]	[35.6385]
Pre-Bubble	No	Δp_{t-1}	0.2664***	0.00006
			[4.6595]	[0.00470]

		Δe_{t-1}	-0.2887**	0.8653***
			[-2.2416]	[28.4478]
Bubble	Yes	Δp_{t-1}	0.1246	0.0097
			[0.9845]	[0.2583]
		Δe_{t-1}	0.2157	0.9141***
			[1.2498]	[17.7719]

Panel B. VECM for post-bubble period

$$\Delta p_t = c_p + \alpha_p z_{t-1} + \sum_{i=1}^{k} a_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} a_{2i} \Delta e_{t-i} + \varepsilon_{1t}$$

$$\Delta e_t = c_e + \alpha_e z_{t-1} + \sum_{i=1}^{k} b_{1i} \Delta p_{t-i} + \sum_{i=1}^{k} b_{2i} \Delta e_{t-i} + \varepsilon_{2t}$$

Period	Bubble	Lags	Δp_t	Δe_t
Post-bubble	Yes	error correction term	-0.2370***	0.0511
			[-4.6615]	[1.6613]
		Δp_{t-1}	0.1696	0.0174
			[1.5724]	[0.2658]
		Δp_{t-2}	0.0981	-0.0216
			[0.9259]	[-0.3360]
		Δe_{t-1}	-0.0652	0.8509***
			[-0.3049]	[6.5698]
		Δe_{t-2}	0.4585**	-0.0974
			[2.1944]	[-0.7700]
Cointegrating Equation	$p_{t-1} - 0.3771^{***} e_{t-1} - 5.5720^{***} = 0$			
	[−9.4000] [−33.5846]			

Panel A of this table reports the VAR model results and Panel B of this table reports the VECM model results. The optimal models are chosen by SIC criterion. The t-statistic is reported in parentheses immediately below the parameter estimate.

*** Statistically significant at 1% level of significance

** Statistically significant at 5 % level of significance

Data source: this study

Formal joint tests of the null hypothesis of no causality between changes in earnings and returns were performed. Table 4 lists the results of the Granger causality test of the changes in log prices (Δp_t) and changes in log earnings (Δe_t). The null hypothesis that Δe_t does not Granger cause Δp_t in the short run is H_0: $a_{21} = a_{22} = ... a_{2k} = 0$, and the null hypothesis that Δp_t does not Granger cause

Δe_t in the short run is H0: $b_{11} = b_{12} = ...b_{1k} = 0$. "Sig" denotes the marginal significance level of the computed χ^2 statistic used to test the null hypothesis of Granger non-causality. The estimated results support H0: $a_{21} = a_{22} = ...a_{2k} = 0$ in the full sample and in the bubble period, implying that changes in earnings Δe_t do not Granger cause stock return Δp_t in the short run when bubbles are present. [2]

Table 4. Granger Causality Test for Full Sample Period and Sub-Periods

	$H_0: \Delta e_t$ does not Granger Cause Δp_t		$H_0: \Delta p_t$ does not Granger Cause Δe_t	
Period	χ^2	Sig	χ^2	Sig
Full sample	0.18655	0.6658	0.03728	0.8469
Pre-bubble	5.02474	0.0250**	0.00002	0.9964
Bubble	1.56194	0.2114	0.06670	0.7962
Post-Bubble [a]	10.51457	0.0052***	0.14601	0.9296

This table reports the short run Granger causality test of the changes in log prices (Δp_t) and changes in log earnings (Δe_t). VAR are performed over full sample, pre-bubble, bubble periods and VECM is performed over post-bubble period. The null hypothesis for Δe_t does not Granger cause Δp_t in the short run is H0: $a_{21} = a_{22} = ...a_{2k} = 0$ and the null hypothesis for Δp_t does not Granger cause Δe_t in the short run is H0: $b_{11} = b_{12} = ...b_{1k} = 0$. Sig denotes the marginal significance level of the computed χ^2 statistic used to test the null hypothesis of Granger Noncausality.

a. VECM analysis is performed over post-bubble period, the joint null hypothesis of no deviations from long run stock price/earnings equilibrium to stock return and no short run causality from changes in earnings to stock returns is $\alpha_p = 0$ and $a_{21} = a_{22} = ...a_{2k} = 0$, and estimated χ^2 -statistics is 27.8880 with marginal significance level 0.000. On the other hand, the joint null hypothesis of no deviations from long run stock price/earnings equilibrium to change in earnings and no short run causality from stock returns to changes in earnings is $\alpha_e = 0$ and $b_{11} = b_{12} = ...b_{1k} = 0$, and estimated χ^2 -statistics is 0.3548 with marginal significance level 0.9494.

*** Statistically significant at 1% level of significance

** Statistically significant at 5 % level of significance

Data source: this study

2 Additional robustness checks were run by excluding recession periods during the first Regan term in early 80s and the George H. W. Bush term in late 80s and early 90s. The Granger causality is still nonexistent for the full sample size. It is likely that the bubble period represents strong bull but the pre-bubble and post-bubble periods contain both bulls and bears.

However, the estimated results rejected H_0: $a_{21} = a_{22} = ...a_{2k} = 0$ in the pre-bubble period at a significance level of .05 and in the post-bubble period at a significance level of .01, implying that changes in earnings Δe_t Granger cause stock return Δp_t in the short run when bubbles are not present. Furthermore, VECM analysis was performed in the post-bubble period, and the null hypothesis of no causality from the error-correcting term (deviations from the long-run equilibrium relationship between stock prices and earnings) to stock returns, $\alpha_p = 0$, was rejected at the 1% level (the *t* statistic was -4.6615), and the joint null hypothesis of no deviations from the long-run stock price/earnings equilibrium to stock returns and no short run causality from changes in earnings to stock returns, $\alpha_p = 0$ and $a_{21} = a_{22} = ...a_{2k} = 0$, was rejected at the 1% level (χ^2-statistic was 27.8880). The estimated results support the predictability of changes in earnings regarding stock returns in the pre- and post-bubble periods.

This study identified that S&P periodically collapsing bubbles began from November 1996 and ended in April 2002. However, periodically collapsing bubbles were not observed for earnings series over the full sample period. High stock price relative to fundamental in the 1990s could be the reason why changes in earnings couldn't grange cause future stock returns.

In summary, the evidence supports the hypothesis that bubbles affect the predictability of stock returns through changes in earnings. This predictability only exists in the periods in which bubbles are not present. However, the null hypothesis that stock returns does not Granger cause changes in earnings was not rejected in the full sample period or in any sub-period.

5. CONCLUSION

It is worthwhile for investors to explore whether earnings provide available information that will be reflected in stock prices. If earnings data accurately reflect business activities and help estimate the fundamental value of a company, earnings data might help forecast future stock prices. By considering the evidence refuting the predictability of stock returns and the breakdown of the relationships between stock price and fundamental when including the 1990s in the sample, I hypothesized that bubbles will affect predictability of stock returns through changes in earnings.

Adopting the forward recursive methodology presented by Phillips et al. (2011), I identified an S&P stock bubble starting in November 1996 and ending in April 2002. November 1996 was one month before Alan Greenspan, the former chairman of the Federal Reserve Board, delivered his famous irrational exuberance speech. I could not identify any periodically collapsing bubbles in earnings series in the full sample period. After controlling for the bubble effect, the evidence shows that stock return respond to changes in earnings in the no bubble periods. In addition, the no-causality results in the bubble period.

Phillips et al. (2011) propose a recursive test procedure for testing explosive behavior and date stamp the origination and collapse of Nasdaq stock bubbles. It is the first study that could identify the origination and collapse of stock bubbles. However, it doesn't discuss bubble effect on stock return predictability. In the current study, I not only identify the origination and collapse of S&P 500 stock bubble but also find that stock bubble is a control factor on predictability of stock return. In other words, the audience gains by looking at this study instead of Phillips et al. (2011)'s is that changes in earnings could predict stock return only when stock bubbles vanish.

This study provides two major contributions: First, it clearly identifies the beginning and ending of the 1990s S&P bubble period. Goyal & Welch (2003), Lettau & Ludvigson (2005), and Ang & Bekaert (2007) all argued that stock returns could not be predicted when the sample includes the 1990s; however, their 1990s sample periods were not consistent and they did not indicate the beginning and end of the 1990s stock bubble period. Second, I present evidence that stock price bubbles affect the predictability of stock returns through changes in earnings, and that this predictability only exists in the periods in which no bubbles are present, the pre-bubble and post-bubble periods. The results are helpful for investors seeking to identify stock bubble periods, realizing the influence and consequence of stock bubbles, and performing their assets allocations.

References

Andrews, D. and Kim, J. Y., 2003, "End-of-sample Cointegration Breakdown Tests." Discussion Paper, Yale University.

Ang, A. and Bekaert, G., 2007, "Stock Return Predictability: Is It There?" **The Review of Financial Studies**, Vol. 20, No. 3, 651-707.

Blanchard, O. and Waston, M., 1982, "Bubbles, Rational Expectations, and Financial Markets" in Wachtel, P. (ed.), **Crises in the Economic and Financial Structure**, First Edition, Lexington, MA: Lexington Book, 295-315.

Blanchard, O., 1979, "Speculative Bubbles, Crashes and Rational Expectations," **Economics Letters**, Vol. 3, No. 4, 387-389.

Campbell, J. Y. and Shiller, R. J., 1988, "Stock Prices, Earnings, and Expected Dividends," **The Journal of Finance**, Vol. 43, No. 3, 661-676.

Curtis, A., 2005, "Can Market Price Diverge from Fundamentals for an Extended Period? Evidence from the Late 1990's." Working Paper, University of New South Wales.

Diba, B. T. and Grossman, H. I., 1988a, "Explosive Rational Bubbles in Stock Prices?" **American Economic Review**, Vol. 78, No. 3, 520-530.

Diba, B. T. and Grossman, H. I., 1988b, "Theory of Rational Bubbles in Stock Prices," **Economic Journal**, Vol. 98, No. 392, 746-754.

Dickey, D. A. and Fuller, W. A., 1979, "Distribution of the Estimators for Auto-Regressive Time Series with a Unit Root," **Journal of American Statistical Association**, Vol. 74, No. 366, 427-431.

Evans, G. W., 1991, "Pitfalls in Testing for Explosive Bubbles in Asset Prices," **American Economic Review**, Vol. 81, No. 4, 922-930.

Fama, E. F. and French, K. R., 1988, "Dividend Yields and Expected Stock Returns," **Journal of Financial Economics**, Vol. 22, No. 1, 3-25.

Fuller, W., 1996, **Introduction to Statistical Time Series**, 2nd, New York: Wiley.

Goyal, A. and Welch, I., 2003, "Predicting the Equity Premium with Dividend Ratios," **Management Science**, Vol. 49, No. 5, 639-654.

Granger, C. W. J., 1969, "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods," **Econometrica**, Vol. 37, No. 3, 424-438.

Johansen, S. and Juselius, K., 1990, "Maximum Likelihood Estimation and Inference on Cointegration-With Applications to the Demand for Money," **Oxford Bulletin of**

Economics and Statistics, Vol. 52, No. 2, 169-210.

Johansen, S., 1988, "Statistical Analysis of Cointegration Vectors," **Journal of Economic and Dynamics and Control**, Vol. 12, No. 2-3, 231-254.

Kothari, S. P., Lewellen, J., and Warner, J. B., 2006, "Stock Returns, Aggregate Earnings Surprises, and Behavioral Finance," **Journal of Financial Economics**, Vol. 79, No. 2, 537-568.

Lamont, O., 1998, "Earnings and Expected Returns," **The Journal of Finance**, Vol. 53, No. 5, 1563-1587.

Lee, B. S., 1996, "Comovements of Earnings, Dividends, and Stock Prices," **Journal of Empirical Finance**, Vol. 3, No. 4, 327-346.

Lee, C. M. C., Myers, J., and Swaminathan, B., 1999, "What is the Intrinsic Value of the Dow," **Journal of Finance**, Vol. 54, No. 5, 1693-1741.

Lettau, M. and Ludvigson, S. G., 2005, "Expected Returns and Expected Dividend Growth," **Journal of Financial Economics**, Vol. 76, No. 3, 583-626.

Pan, M. S., 2007, "Permanent and Transitory Components of Earnings, Dividends, and Stock Prices," **The Quarterly Review of Economics and Finance**, Vol. 47, No. 4, 535-549.

Phillips, P. C. B. and Perron, P., 1988, "Testing for a Unit Root in Time Series Regression," **Biometrica**, Vol. 75, No. 2, 335-346.

Phillips, P. C. B., Wu, Y., and Yu, J., 2011, "Explosive Behavior in the 1990s Nasdaq: When Did Exuberance Escalate Asset Values?" **International Economic Review**, Vol. 52, No. 1, 201-226.

Sadka, G., 2007, "Understanding Stock Price Volatility: the Role of Earnings," **Journal of Accounting Research**, Vol. 45, No. 1, 199-228.

Schwarz, G., 1978, "Estimating the Dimension of a Model," **The Annals of Statistics**, Vol. 6, No. 2, 461-464.

Shiller, R. J., 2005, **Irrational Exuberance**, 2nd, Princeton, NJ: Princeton University Press.

Vuolteenaho, T., 2002, "What Drives Firm-Level Stock Returns?" **Journal of Finance**, Vol. 57, No. 1, 233-264.

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