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Putting the Dividend-Price Ratio Under the Microscope

by

Jun Nagayasu

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Jun Nagayasu*

Graduate School of Systems and Information Engineering
University of Tsukuba

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Abstract

We analyze the time-series properties of the dividend-price ratio (*dpr*) often used as one determinant of stock returns. Using, among others, the Saikkonen-Lütkepohl unit root test that considers regime shift effects, evidence is obtained of a non-stationary *dpr* for Japan. Therefore, in contrast to studies of other industrialized countries, we find no significant one-to-one long-run relationship at all between Japanese stock prices and dividends.

JEL classification: G100, E440, C120, C220

Keywords: Persistence, dividends, stock prices, unit root tests

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*Corresponding author: Jun Nagayasu; Mailing address: Graduate School of Systems and Information Engineering, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8573, Japan; Telephone and fax: +81 29 853 5067; Email: Nagayasu@sk.tsukuba.ac.jp. Part of this paper was written while the author was a visiting scholar at the Cass Business School, London.

1   Introduction

Stock dividends are an increasingly important factor for investors making financial portfolio decisions, particularly in Japan where interest rates are at almost zero percent and stock prices have stagnated for more than a decade.

The time series properties of the dividend-price ratio (dpr_t) have been discussed, for example, by Campbell and Shiller (1989) in the context of the present value model for the stock return (r_t). Their theory suggests that the dpr_t contains useful information for predicting stock returns and dividend growth: a high dpr_t must be accompanied by a high stock return and/or low dividend growth. Furthermore, this theoretical relationship indicates that the dividend, div_t, and the stock price, p_t, are integrated of order one (i.e., $I(1)$), and r_t and dpr_t are stationary (i.e., $I(0)$). The stationary dpr_t implies that a long-run and negative relationship exists between div_t and p_t.[1]

The assumption about a stationary dpr_t seem to hold in the U.K. and U.S. Using the conventional unit root tests, Campbell and Shiller (1989) raise evidence in favor of stationarity for the U.S. dpr_t. While Balk and Wohar (2002) provide evidence of a non-stationary dividend-price ratio also using the standard tests, Bohl and Siklos (2004) and Madsen and Milas (2005) find some supportive evidence of stationarity in the U.S. ratio by allowing possible asymmetric short-term adjustments to the test. For the U.K. data, the standard Augmented Dicky-Fuller test seems sufficient to reject the null (Madsen and Milas 2005).

Against this background, this paper analyzes the time-series properties of dpr_t and its component, p_t, for Japan. To our knowledge, no one has has yet questioned the validity of the stationary Japanese dpr_t as intensively as this study. Furthermore, this paper distinguishes itself from previous studies by implementing a relatively new statistical method: the Saikkonen and Lütkepohl test (2002) that considers the effects of unknown structural breaks and which has never been implemented in this area.

2   Data and Empirical Results

Our data are monthly, and include the stock return and dividend-price ratio from January 1955 to January 2005 for Japan. This sample period may be prone to containing regime shifts, but must be long enough to obtain estimates that do not suffer from small sample bias. The stock return is based on the log difference of the average stock prices listed on the first division of the Tokyo Stock Exchange. The data are obtained from the Nikkei Database which is probably the most comprehensive data set to analyze economic and financial developments in Japan.

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[1]However, Campbell-Shiller's present value model may not hold because of time varying rates of returns, speculative bubbles, omitted variables such as retained earnings (MacDonald and Power 1995), or regime shifts in the data (Balke and Wohar 2002).

Whether the time-series is stationary, persistent, or non-stationary can be ascertained by the size of the differencing term, d. Granger and Joyeaux (1980) for example show that a data process is covariance stationary and persistent for $-1/2 < d < 1/2$ ($d \neq 0$), while $|d| \geq 1/2$ indicates a non-stationary process since its variance is infinite. When $d = 0$, the data is said to follow a stationary process.

In order to examine their time-series properties, we first implement unit root tests: the Augmented Dicky-Fuller (ADF) and the Saikkonen-Lütkepohl (SL) tests. The latter test takes into account the effects of unknown structural regimes in the data. Implementation of the SL test is important because in the presence of regime shifts, the ADF has very low power to reject the null hypothesis (Perron 1997).

More specifically, the SL unit root test examines the null hypothesis of the unit root ($d = 1$) based on the following general specification.

$$y_t = \mu_0 + \mu_1 t + f_t(\theta)'\gamma + x_t \tag{1}$$

where t is a time trend, and the residual, x_t, is assumed to follow a finite order autoregressive form, $b(L)(1 - \rho L)x_t = \varepsilon_t$ where L is a lag operator, $-1 < \rho \leq 1$, and $\varepsilon_t \sim iid(0, \sigma^2)$. The shift function, $f_t(\theta)$, is dependent on θ and the regime shift date, T_B. We consider the following two shift functions.[2]

$$f_t^1 \gamma = d_{1,t}\gamma = \begin{cases} 0 & t < T_B \\ \gamma & t \geq T_B \end{cases} \tag{2}$$

$$f_t^2(\theta)'\gamma = \begin{cases} 0 & t < T_B \\ \gamma_1 & t = T_B \\ \gamma_1 + \sum_{j=1}^{t-T_B} \theta^{j-1}(\theta\gamma_1 + \gamma_2) & t > T_B \end{cases} \tag{3}$$

The shift function, f_t^1, represents a shift dummy indicating a permanent level shift, and is not dependent on θ. In contrast, the rational function, f_t^2, is more flexible and can generate a smooth or abrupt shift from one regime to another.[3] The parameters, γ_1 and γ_2, correspond to those in the lag operator: $[\gamma_1(1-\theta L)^{-1} + \gamma_2(1-\theta L)^{-1}L]d_{1,t}$, which is another expression of $f_t^2(\theta)'\gamma$. This test can be carried out by first estimating the deterministic terms by means of the generalized least squares (GLS), and then by applying the ADF to the adjusted data that can be obtained by removing the deterministic components. The T_B corresponds to the date when the GLS objective function is minimized (Lanne et al 2002).

Table 1 summarizes the results from these unit root tests, and suggests that r_t and dpr_t are not integrated of the same order. In particular, while r_t is $I(0)$ (and p_t is $I(1)$), dpr_t is $I(1)$. The SL statistics imply possible shift dates for Japan which are mostly early

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[2]In addition, Saikkonen and Lütkepohl (2002) propose an exponential shift function. However, we failed to obtain results because of a singularity problem.

[3]A smooth transition can be obtained for a smaller value of θ.

1990s when the economy went into recession. This is largely consistent with Madsen and Milas (2005) who find a structural shift in the U.S. dpr_t that is determined by the level of inflation rates. However, the fact that our results from the ADF test are consistent with those of the SL test indicates that regime shifts in r_t and dpr_t are not significant in Japan.[4]

The robustness of this result on the order of integration is checked using the Geweke and Porter-Hudak method, GPH, (1983). They propose a spectral procedure to estimate the differencing parameter, and argue that the estimates obtained from their method can be evaluated using the conventional Student t statistic. In contrast to the standard unit root tests that examine the differencing parameter, d, as being either one or zero under the hypotheses, the GPH estimates the size of d. Thus the GPH allows d to differ from these two extreme numbers. Furthermore, this test is relatively more robust to non-normality which is a common characteristic in financial data (Agiakloglou et al 1992). The results are reported in Table 2 and confirm the findings of our unit root tests: $d = 0$ for r_t and $d \neq 0$ for dpr_t. Furthermore, the size of d for dpr_t is greater than $1/2$, thereby indicating that dpr_t is not even persistent but non-stationary. A non-stationary dpr_t is inconsistent with most previous research using U.K. and U.S. data as stated in the Introduction.

3   Summary and Discussion

This paper examines the time-series properties of the dividend-price ratio and stock return. First, we reached a conclusion that there are no significant structural shifts in the data. Furthermore, we provided very convincing evidence of the dividend-price ratio being non-stationary; in contrast, the stock return is stationary. As a result, the applicability of the present-value model for stock returns developed by Campbell and Shiller (1989) may be limited in Japan simply because the time-series properties of the data differ from their assumption. Our result is in contrast to most studies using the data of other industrialized countries, and may be attributable to the dividend policy in Japan where many firms have provided a stable amount of dividends regardless of business conditions or the level of stock prices, in order to maintain a business relationship with shareholders (Nagayasu 2005).

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[4]We have also implemented Perron's unit root test (1997) that takes into account regime shifts. While the shift dates detected by Perron's test differ somewhat from those of the SL, the result as to whether or not the data are stationary is consistent with those from the SL test.

References

Agiakloglou, C., P. Newbold and M. Wohar, 1992, Biases in an estimator of the fractional difference parameter, Journal of Time Series Analysis, 14, 235-246.

Balk, N. S. and M. E. Wohar, 2002, Low frequency movements in stock prices: a state-space decomposition, Review of Economics and Statistics 84, 649-667.

Bohl, M. T. and P. L. Siklos, 2004, The present value model of U.S. stock price index: a new testing strategy and some evidence, Quarterly Review of Economics and Finance, 44, 208-223.

Campbell Y. J. and R. Shiller, 1989, The dividend-price ratio and expectations of future dividends and discount factors, Review of Financial Studies 1(3), 195-228.

Davidson, R. and J. MacKinnon, 1993, Estimation and Inference in Econometrics (Oxford University Press, London).

Geweke, J. and S. Porter-Hudak, 1983, The estimation and application of long memory time series models, Journal of Time Series Analysis 4, 221-238.

Granger, C.W.J. and R. Joyeaux, 1980, An introduction to long memory time series models and fractional differencing, Journal of Time Series Analysis 1, 15-39.

Lanne, M., H. Lütkepohl, and P. Saikkonen, 2002, Comparison of unit root tests for time series with level shifts, Journal of Time Series Analysis 23(6), 667-685.

MacDonald, R. and D. Power, 1995, Stock prices, dividends and retention: long-run relationships and short-term dynamics, Journal of Empirical Finance, 12, 135-151.

Madsen, J.B. and C. Milas, 2005, The price-dividend relationship in inflationary and deflationary regimes, Finance Research Letters, forthcoming.

Nagayasu, J., 2005, Determinants of the Tokyo Stock Price Index: searching for explanations of the depression, Discussion Paper Series No. 1117, Department of Social Systems and Management, University of Tsukuba, Japan.

Perron, P., 1997, Further evidence on breaking trend functions in macroeconomic variables, Journal of Econometrics 80, 355-385.

Saikkonen, P. and H. Lütkepohl, 2002, Testing for a unit root in a time series with a level shift at unknown time, Econometric Theory 18, 313-348.

Table 1: **Unit Root Tests**

| | Level | | First difference | |
	Statistics (lag)	Shift dates	Statistics (lag)	Shift dates
Stock price (p_t)				
ADF	-1.428 (1)	–	-17.710 (0)	–
SL^1	-1.596 (1)	1975:05	-5.606 (0)	1992:09
SL^2	-1.475 (1)	1970:05	-16.564 (0)	1990:05
Dividend-price ratio (dpr_t)				
ADF	-1.799 (1)	–	-21.512 (0)	–
SL^1	-2.014 (1)	1990:10	-3.891 (0)	1990:10
SL^2	-1.833 (1)	1990:10	-19.536 (0)	1990:10

Note: The first difference of the log stock price p_t is equivalent to the stock return (r_t). The constant term is included in the unit root test. The SL^1 is based on a shift function (equation 2) and SL^2 on equation (3). The critical values (the five percent significance level) for the ADF and SL tests are -2.86 (Davidson and MacKinnon 1993) and -2.88 (Lanne *et al* 2002). The lag orders are determined by the Akaike Information Criterion.

Table 2: **The Geweke and Porter-Hudak Method**

| | Level | First difference |
	Statistics (p-values)	Statistics (p-values)
Stock price (p_t)		
d	0.768 (0.003)	-0.087 (0.738)
Dividend/price ratio (dpr_t)		
d	0.637 (0.014)	-0.073 (0.781)

Note: The first difference of the log stock price, p_t, is equivalent to the stock return, r_t. The size of bandwidth is based on $T^{0.44}$.