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What Drives Stock Prices? Fundamentals, Bubbles and Investor Behavior

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Abstract

Using a dynamic version of the present value model and a range of developed and Asian emerging markets, this paper considers estimates of stock market prices given expectations on dividends and earnings and compares these fundamental stock prices with actual stock prices. The reported empirical results suggest that a dynamic present value model combined with differing definitions of cash flows can explain actual stock price movements for many of the sample markets. For markets where price deviations from fundamental value are statistically significant, the revealed deviations are investigated by considering types of investor behavior which might drive such departures.

Key words: present value; cash flow; risk premium; price deviation; rational bubble

JEL Classification Codes: G12, G18, R31.

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1. Introduction

The extant debate on the behavior of asset prices has a long history in the academic literature with much of the current debate on 'what drives stock prices' having its genesis in the work of Williams (1938), Keynes (1964) and Lucas (1978). Keynes argues that investment is no more than a 'game of chance' with investors merely 'anticipating average expectations', while Williams and, subsequently, Lucas, set the scene for the efficient markets view that fluctuations in stock prices are the rational response to changes in the expected present value of future cash flows.

More recently, the literature tends to have two, not unrelated, foci: first, the validity of the traditional present value model, and second, statistical and measurement issues surrounding the modelling and measurement of cash flows. For example, early variance bound tests found that the simple constant dividend discount model could not explain U.S. stock price movements (LeRoy and Porter, 1981, Shiller, 1981). While the statistical validity of the variance bounds tests was vigorously disputed (Kleidon, 1986, Marsh and Merton, 1986), strong evidence against the simple present value model persisted even when issues such as small sample bias, constant discount rates and the time series characteristics of the data were accounted for (Flavin, 1983, Campbell and Shiller, 1987, West, 1988, Cochrane, 1991, and Fama, 1991).

Rejections of the traditional present value model (mainly on U.S. data) led, in turn, to the introduction of alternative inductive-type models of stock valuation such as: slow adjustment to fundamentals (DeLong et al., 1990); irrational traders (Culter et al., 1990); and investor overconfidence (Daniel et al., 1998). This 'behavioral finance' approach to investor behavior is underpinned by the view that financial phenomena can be better understood using models in which financial agents may not act in accordance with the predictions of the efficient markets view of stock market valuation.[1]

The seminal paper by Ackert and Smith (1993) however, did much to shift the debate back to the validity of the present value model itself by considering issues concerning the measurement of the cash flows upon which expectations are formed. Reporting results using Canadian (TSE) stock data and the excess volatility testing procedure, Ackert and Smith were able to support the efficient markets view of stock valuation when cash dividends were substituted by a broader measure of income which included share repurchases and takeover distributions in addition to cash dividends. This led to the development of a range of alternative present value models using different definitions of cash flows according to the assets and issues being investigated. Kallberg et al. (2003) for example adapt the present value model to real estate investment trust prices, while Jiang and Lee (2005) utilize the present value framework to test the accounting based residual income model.

This paper adds to these strands of the literature in several ways. First, given the rejections of the traditional constant return present value model, we incorporate into the model the more realistic assumption that the expected return of wealth holders is time-varying.[2] The model therefore is dynamic in nature – arguably a necessary requirement for the analysis of prices set by forward-looking agents in vigorous, fast evolving, and increasingly global, marketplace.

Second, we approach the empirical question of how to measure fundamental stock prices by constructing these within a *3*-variable vector autoregressive (VAR) modelling framework. In essence this method captures the relationship between market prices and expected cash flows in the spirit of the *2*-variable VAR initiated by Campbell and Shiller (1987, 1988) but one where we allow risk to vary over time. Non-linear restrictions on the *3*-variable VAR are then derived in order to test statistically the extent of sustained deviations of actual stock prices from their fundamental counterparts. Thus the 'forward-looking' present value model within a VAR modelling framework and including a time-varying expected return, allows us to estimate what stock prices 'should have been' over the period (subject to the maintained hypothesis) and to compare these with actual prices..

Third, we widen as well as deepen the data analyses by assessing the relative importance of expected dividends and expected earnings in determining stock index movements in a range of developed and emerging markets. To do this, we utilize two different definitions of cash flows both of which are in the public domain, namely the narrowly defined (index) cash dividend and the broader measure of (index) earnings. Therefore, unlike previous studies where the tendency has been to use less aggregated accounting-based measures of cash flows, this paper offers an additional insight into price dynamics by considering readily available, market information on economy-wide cash flows.

Finally, we analyse any revealed deviations from fundamental value by considering the investor behavior which might drive such deviations. In particular we focus on the extent to which observed deviations are driven by a 'rational' overreaction to fundamentals (Froot and Obsfeld, 1991). This is important not only for academic insights into investor behavior but also for highlighting to policy makers, at micro, macro and international levels of activity, the type of aggregate information that investors in these markets are likely to respond to and, how this might change over time: whether proactive or reactive, optimal policy decisions at all levels of activity require a sound knowledge of the factors which drive investor behavior, therefore stock prices.

We begin, in section 2, by setting out the theoretical and empirical framework used to measure fundamental prices. Section 3 discusses the data used and preliminary statistics, while the empirical results are discussed in section 4. The rational bubble explanations of price deviations from fundamentals are discussed and analysed in section 5. Section 6 offers concluding remarks.

2. Theoretical and Empirical Framework

2.1 The Dynamic Present Value Model

The present value formula for stock prices can be written as:

$$P_t = E_t \sum_{i=1}^{\infty} \left(\frac{1}{\prod_{j=1}^{i} (1+\rho^*_{t+j})} \right) C_{t+i} \qquad (1)$$

where P_t is the real price at the end of period t, C_{t+i} are real cash flows paid to share holders during time $t+i$, and ρ^* denotes a possibly time-varying discount rate.

Equation (1) is a particular solution to the standard theory of stock price determination:

$$P_t = \frac{1}{1+\rho} \mathrm{E}_t (P_{t+1} + C_{t+1}) \quad (2)$$

Taking logs of equation (2) and defining r as $\ln(1+\rho)$ to represent one-period logged gross return, this equation can be used to show the relationship between the ex post one-period gross returns, logged prices and logged dividends:

$$r_{t+1} = \ln(P_{t+1} + C_{t+1}) - \ln(P_t) \quad (3)$$

This relationship is non-linear since it involves the log of the sum of the price and the cash flow. However, by using a first-order Taylor's approximation, the non-linear relationship of equation (3) can be linearized to be:

$$r_{t+1} = k + \mu(p_{t+1} - c_{t+1}) - (p_t - c_t) + \Delta c_{t+1} \quad (4)$$

where lower-case letters denote the logs of their upper-case counterparts. Equation (4) consists of the constants, k and μ, the logged gross return r, the real cash flow growth, Δc_{t+1} , as well as the term *(p-c)* that represents the logged price/cash flow ratio for the stock market as a whole.

This linear approximation of the non-linear relationship in equation (4) holds when we define k and μ as:

$$\mu = 1/\left(1 + \exp\overline{(c - p)}\right) \tag{5}$$

$$k = -\ln\mu - (1-\mu)\cdot\overline{(c - p)} \tag{6}$$

where $\overline{(c - p)}$ is the sample mean of $(c\text{-}p)$ about which the linearization was taken. By this definition, clearly μ is the average of the discount factor, which has the property of $0 < \mu < 1$, and in practice μ is close to 1.

Empirically, it is common that both P and C are $I(1)$, which might pose a problem in analysing equation (3) econometrically. Taking a linearization of equation (3) is convenient in that the equation (4) consists of variables that are all stationary. Denote by pc_t the logged price/cash flow ratio, $p_t - c_t$, and rewrite equation (4) as:

$$pc_t = k + \mu pc_{t+1} + \Delta c_{t+1} - r_{t+1} \tag{7}$$

After repeated substitution for $pc_{t+1}, pc_{t+2}, \ldots$ on the right hand side of (7), we get:

$$pc_t = \frac{k(1-\mu^i)}{(1-\mu)} + \sum_{j=0}^{i-1}\mu^j \Delta c_{t+j+1} - \sum_{j=0}^{i-1}\mu^j r_{t+j+1} + \mu^i pc_{t+i} \tag{8}$$

Assuming the non-linear bubble transversality condition holds (i.e. $lim_{i\to\infty} u^i pc_{t+i} = 0$), equation (8) implies that the logged price/cash flow ratio is stationary, $pc_t \sim I(0)$. Further, letting $i \to \infty$ results in the following alternative form of (8):

$$pc_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j \Delta c_{t+j+1} - \sum_{j=0}^{\infty} \mu^j r_{t+j+1} \tag{9}$$

If $c_t \sim I(1)$ then $\Delta c_t \sim I(0)$ and, assuming that $r_t \sim I(0)$ (recall that it is the real discount rate), we then have the model linearized and expressed in terms of stationary variables. Finally, taking conditional expectations of both sides of equation (9):

$$pc_t = \frac{k}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j E_t^c \Delta c_{t+j+1} - \sum_{j=0}^{\infty} \mu^j E_t^c r_{t+j+1} \tag{10}$$

where E_t^c are conditional expectations and we interpret r_{t+j+1} as investor's required rate of return.

Equation (10) states that the logged price/cash flow ratio is equal to the expected discounted value of future real cash flow growth in excess of one-period expected return, plus a constant. One noteworthy point is that all the variables in equation (10) are measured ex post. The logged price/cash flow ratio and cash flow growth can be observed, but the investor's expected return is unobservable. This model is econometrically useful if we are willing to impose some restrictions on the behavior of expected return, i.e. $\mathrm{E}_t^c r_{t+1}$.

2.2 Fundamental Prices v. Actual Prices

In order to use (10) to generate a series for the fundamental price/cash flow ratio implied by the model and from it the implied fundamental stock price, we need to obtain empirical counterparts to the terms on the right hand side involving expectations. For the expectation of cash flow growth, we follow Ackert and Smith (1993) by considering different definitions of cash flows. However, unlike Ackert and Smith who use disaggregated data and supplement cash dividends with share repurchases and takeover distributions, we consider two aggregate fundamental factors that are readily available in the public domain, namely (index) cash dividend growth and (index) earnings growth. Both dividends and earnings are then independently incorporated into a *3*-variable VAR model. With the use of two conventional fundamental factors, the present value model therefore addresses the issue concerning the measurement of real cash flows from an economy-wide and publicly available perspective. [3]

For the second term on the right hand side of (10) we assume a time-varying expected return. By relaxing the constancy assumption of the traditional present value model, the dynamic present value model incorporates the more realistic assumption that the expected return required by investors varies over time according to the state of the economy. In the empirical VAR, we decompose the real required return into a constant safe or risk-free rate and a time-varying risk premium. Here we follow the work of Merton (1973, 1980) on the intertemporal CAPM, and model the time-varying risk premium as the product of the coefficient of relative risk aversion (*CRRA*), α, and the expected variance of excess returns, $E_t^c \sigma_t^2$. The model therefore is forward-looking and dynamic in nature.

The equation for the price/cash flow ratio then becomes:

$$pc_t = \frac{k-f}{(1-\mu)} + \sum_{j=0}^{\infty} \mu^j E_t^c \Delta c_{t+j+1} - \alpha \sum_{j=0}^{\infty} \mu^j E_t^c \sigma_{t+j+1}^2 \qquad (11)$$

where f is the constant real risk free component of real required returns. We can forecast real cash flow growth and stock return variance using a *3*-variable VAR in $z_t = \left(pc_t, \Delta c_t, \sigma_t^2\right)'$. The empirical VAR is written in compact form as:

$$z_t = \mathrm{A} z_{t-1} + \varepsilon_t \qquad (12)$$

where A is a (3×3) matrix of coefficients and ε is a vector of error terms. Here we assume a lag length of 1 for ease of exposition. If, in the empirical application a longer lag length is required, the companion form of the system suggested by Sargent (1979) can be used.

Then forecasts of future z_t on j periods ahead are easily obtained as:

$$\mathrm{E}_t\left(z_{t+j}\right) = \mathrm{A}^j z_t \qquad (13)$$

By notation, we can define three unit vectors, $e_1 = [1,0,0]'$, $e_2 = [0,1,0]'$ and $e_3 = [0,0,1]'$ to pick up the three elements, pc_t, Δc_t, and σ_t^2 respectively, so that

$e_1' z_t = pc_t$, $e_2' z_t = \Delta c_t$ and $e_3' z_t = \sigma_t^2$. We are then able to estimate their empirical counterparts and replace the expectations in equation (11) to get:

$$
\begin{aligned}
pc_t^* = e_1' z_t &= \frac{k-f}{1-\mu} + \sum_{j=0}^{\infty} \mu^j (e_2' - \alpha e_3') \mathrm{A}^{j+1} z_t \\
&= \frac{k-f}{1-\mu} + (e_2' - \alpha e_3') \times (\mathrm{A} + \mu \mathrm{A}^2 + \mu^2 \mathrm{A}^3 + \ldots) z_t \\
&= \frac{k-f}{1-\mu} + (e_2' - \alpha e_3') \mathrm{A} (\mathrm{I} - \mu \mathrm{A})^{-1} z_t \qquad (14)
\end{aligned}
$$

From equation (14), we can see that once we have estimated the VAR coefficients and the constants, μ, k and f, the construction of the logged fundamental price/cash flow ratio pc_t^* is straightforward. Furthermore, from the logged fundamental price/cash flow ratio implied by the model, we can generate a series for the logged stock prices that is warranted by (predicted) cash flow growth:

$$p_t^* = pc_t^* + c_t \qquad (15)$$

The logged fundamental stock price index p_t^* therefore is the optimal forecast of the log-linearized present value of real cash flows, c_t .

Equation (14) can also be used to derive the test of how far actual stock prices deviate from their fundamental value as warranted by real cash flows. Given the ‘dynamic’ present value model, equation (14) implies restriction on the behavior of the actual logged price/cash flow ratio (hence the actual stock price). The restriction can be seen more clearly if we transform the variables into the deviations from their means. This removes the constant term, and hence equation (14) can be written as:

$$e_1' z_t = (e_2' - \alpha e_3') \mathrm{A} (\mathrm{I} - \mu \mathrm{A})^{-1} z_t \qquad (16)$$

For this to hold for all realizations of z_t, we require:

$$e_1' - (e_2' - \alpha e_3') \mathrm{A} (\mathrm{I} - \mu \mathrm{A})^{-1} = 0 \qquad (17)$$

which constitutes a set of 3*p* (i.e. variables × lag length) non-linear restrictions on the VAR coefficients. These restrictions can be tested by a non-linear Wald test. If we write the estimated vector of VAR coefficients as γ, the estimated variance covariance matrix of these coefficients as Ω, and the vector of deviations of the estimated system from the model as τ, then the non-linear Wald test statistic is:

$$\tau' \left[(\partial \tau / \partial \gamma)' \, \Omega (\partial \tau / \partial \gamma) \right]^{-1} \tau \qquad (18)$$

Under the null hypothesis equation (18) is distributed χ^2 with degrees of freedom equal to the number of restrictions (the number of elements of τ). The derivatives of τ with respect to the VAR parameters can be calculated numerically. The non-linear restrictions are simply a test of deviations of actual logged price/cash flow ratio's against their theoretical counterparts, since in equation (17) the first unit vector e_1'

picks out the element pc_t, and the second term explains the construction of the fundamental or warranted price/cash flow ratio, pc_t.

3. Data and Preliminary Statistics

3.1. Data

Several financial instabilities from 1980s, including the Japanese Asset Price Bubble (1987-1990), the Asian Crisis (1997-1998) and the Dot-Com Bubble (1997-2001), have been documented as 'bubble' periods (see Siebert, 2002). However, many financial players and observers refute the view of sustained mass hysteria being the major driver of asset prices. To see whether the dramatic rise and subsequent collapse of stock prices experienced in recent history is related to changing fundamentals, we employ data on markets that are commonly perceived as having been particularly sensitive to 'bubble phenomena'. The sample therefore encompasses the stock markets of the U.S., U.K., and the Asian markets of: Hong Kong; Japan; Singapore; South Korea; Malaysia; Thailand; Taiwan; and Indonesia. The raw data with monthly frequency are collected from Datastream Advance and include Datastream Global Indices, dividend yields, and price/earnings ratios, as well as the respective risk-free rates of return.

While the Global Indices are constructed in an identical manner in order to permit cross-country analysis, the time period analysed for the less developed markets is restricted by the availability of data. Given the analysis is mainly concerned with identifying deviations from fundamental value on a period-by-period basis, the empirical work utilizes the full set of available data for each market rather than a common sample (which would have necessarily had a starting point in the 1990s). The full sample periods analysed are displayed in Table 1.

The monthly dividend and earnings series are constructed from the annualised dividend yield and price/earning ratio series in Datastream. Stock returns and growth rates in dividends and earnings are continuously compounded. The variables of interest are all in real terms being inflation adjusted by the appropriate consumer price index. In the empirical work reported below, real earnings data are scaled so that the log of the real stock prices/earnings ratio is in the same units of measurement as the log of the real price/dividend ratio. The scale factor is calculated as $[(1+R)P_{t-1}-P_t]/C_{t-1}$ where R is the real required return, P_t is the value of the stock price index at time t and C_{t-1} is lagged real cash flow. The value of R is calculated as the sample average monthly change in the gross (dividends included) price index.

Once these variables are defined, the linearization constants, μ and k, can be calculated from equations (5) and (6). If available, the risk-free rate (f_t) series' are measured as the continuously compounded monthly returns from the 90-day Treasury Bill (TB) rate. If appropriate TB rates are not available we use a relatively unregulated rate of return.[4]

The restrictions imposed on the model also requires a measurement of the *CRRA*, α. In accordance with Merton (1973, 1980) and Boyle (2005), α is imposed on the model and measured as: $\frac{\overline{er}+(\sigma_{er}^2/2)}{\sigma_{er}^2}$, where er denotes returns in excess of the risk free rate, an overbar denotes a mean value, and σ_{er}^2 denotes the variance of returns in excess of the risk free rate. In order to avoid the necessity of including a constant term in the VAR equations, the variables in the VAR are then redefined to be in terms of deviations from their sample mean values.

3.2. Preliminary Statistics

The upper part of Table 2 provides summary statistics for the series of monthly gross (capital appreciation with dividend yield) returns and risk free rates. Hong Kong displays the highest monthly gross return, while Indonesia is the only market to have a negative gross return over the period. To identify more precisely the relative performance of the stock markets, we also report Sharpe ratio's, which indicates for each market the amount of excess return generated per unit of ex-post risk taken (the latter measured by volatility). The ratio's suggest that while Asian markets are associated with relatively high volatility, only the Hong Kong market displays relatively high real average returns per unit of risk taken. The relatively high volatility of the Asian markets has been proposed as an explanation as to why it is generally believed that Asian markets are particularly susceptible to bubbles (see, for example, Krugman, 1997).

Table 2 also provides summary statistics for the series of monthly dividends and earnings. The mean earnings and dividends were, again, highest for Hong Kong and lowest for Indonesia. For each market the standard deviation of earnings exceeds that reported for dividends. In addition, the coefficient of variation (C.V.) for the earnings series is also generally greater than that for dividends. Both results suggest that the earnings series are more volatile, supporting the view that dividends tend to be managed across markets.

For the VAR model to be stable, the variables are required to be stationary. We therefore report standard unit root tests on the variables to be included in each VAR. As can be seen in Table 3, the results suggest that the logged price/dividend ratio and logged price/earning ratio are stationary for most markets except for the U.K., Japan and Taiwan (with the U.K. being borderline stationary). The mixed results on the stationarity properties of the dividend and earnings ratio's accord with those reported in previous studies, and are not surprising as unit root tests are known to have low power (e.g. Perron, 1989, 1997; Fraser et al., 2008). By analysing similar data series, Black, Fraser and Groenewold (2003) suggest that this may be a function of sample size and a slowly mean-reverting process. For completeness therefore, we also conducted cointegration tests, the results of which indicated that the logged real net price index and the logged dividend for each market were cointegrated and therefore the ratio's have a long-run stable relationship.[5] The unit root test statistics also indicate that dividend growth rates, earnings growth rates and the return variances in excess of risk free rates are stationary.

4. Empirical Results

VAR statistics for the developed markets and the less developed markets are reported in Tables 4 and 5 respectively. The table reports considerable variation in the optimal lag length imposed on the VAR systems with the shortest and longest lag lengths being for the more developed Asian markets of Hong Kong and Japan. While the U.S.

and Japanese earnings model required more lags than their corresponding dividend model, VAR specifications for all markets appear to be adequate with the *Q* statistics indicating that model residuals are serially uncorrelated.

The *CRRA* for the U.S. is close to the Campbell and Shiller's (1988) estimate of 2.6 using the Cowles/Standard and Poor 500 index – a feature which would imply that in developed markets at least, the *CRRA* remains fairly constant over time.[6] For the developed markets, the reported *CRRA* are within plausible bounds of 1 to10 (Able, 1991, p.9), while this is less obvious for the less developed stock markets where only Malaysia is in this range. Further, the Indonesian market reports a negative *CRRA* over the sample period. The relatively lower *CRRA* reported for the less developed markets would support the view that investors in such markets are relatively less risk averse than those operating in the more developed markets.

For all markets in the sample, the *R* squared is highest for the logged price/cash flow ratio, due in part to the high significance of the 'own lag' in this equation. This is not surprising given that the logged price/cash flow ratio reflects the outlook for dividends and discount rates (as in equation (10)). With the exception of Japan, the *R* squared for dividend growth and return variance in the dividend models are higher in the developing markets than in the more developed markets. Generally, however, in the earnings models, it is the return variance in the developing markets which has the relatively high *R* squared when compared to the developed markets (with Thailand being the exception to this) and also a relative low coefficient of determination on the price to earnings equation.

Non-linear Wald tests are reported in Table 6. Interestingly, while using the dividend model, the non-linear Wald tests can be convincingly rejected for the more developed markets, this is not the case for the earnings model where, with the exception of Hong Kong and Singapore, the gap between actual prices and those prices warranted by earnings are statistically insignificant. In contrast, we see that the dividend model is supported at least at the 1% significance level for the developing markets of Thailand, Taiwan and Indonesia, while for Korea and Malaysia the earnings model provides a more realistic reflection of actual prices. The results suggest that expected earnings drive stock prices in the developed markets of the U.S., U.K. and Japan but neither the dividend discount model nor the earnings discount model can explain the time path of stock prices in Hong Kong and Singapore. In the less developed markets, while there is evidence that earnings have a role to play in the Korean and Malaysian market, it would appear that dividends have relatively more influence in the markets of Thailand, Taiwan and Indonesia albeit at the lower bound of statistical significance.

The non-linear Wald test statistics are also supported by the graphs. It is clear from Figure 1 that, for the U.S., U.K., Japan, Korea and Malaysia, the gap between the fundamental price constructed by earnings and actual stock price is smaller than the gap between the fundamental price constructed by dividends and actual stock prices. This indicates that the price/earnings ratio has more explanatory power in tracking investor behavior than the price/dividend ratio, suggesting that, for these markets, the earnings series holds additional relevant information to that captured by cash dividends alone. Surprisingly, for Hong Kong and Singapore, actual stock prices display significant and sustained deviations from those warranted by dividend or earnings. An interesting question therefore is what other factors might drive stock prices in the Asian developed markets of Hong Kong and Singapore?

5. Bubble Phenomena

5.1 Characteristics of Rational Bubbles

In response to rejections of the present value model, Blanchard and Watson (1982) and West (1987) have suggested that variance bounds may be violated as a result of the presence of rational explosive bubbles. The presence of rational explosive bubbles not only is entirely consistent with rational expectations, it also satisfies the martingale property of the present value model (Cuthbertson and Nitzsche, 2004). Moreover, because the driving force of rational explosive bubbles is an extraneous event such as time or expectation, it is a self-fulfilling deterministic phenomenon. Indeed, the deterministic trend of the bubble is so extreme and persistent that stock price movements are actually ‘explosive’.

Nevertheless, using the condition of rational expectation equilibrium, Tirole (1982) has argued that rational bubbles cannot exist in a model with a finite number of infinitely lived rational agents. By extending the study of bubbles into a model with an infinite number of finitely lived agents, Tirole (1985) argues that rational bubbles can arise only when the economy is dynamically inefficient. However, dynamic inefficiency is unlikely to occur in practice (Blanchard and Fischer, 1989, and Abel et al., 1989).

Blanchard and Watson (1982) further argue that rational bubbles can also take the form of more complex stochastic (rather than deterministic) processes. Evans (1991) describes a class of periodically collapsing bubbles that is stochastic and nonlinear in nature. Froot and Obstfeld (1991) also posit that sustained deviations of asset prices from fundamental values can be explained by the presence of a particular type of rational bubbles called ‘intrinsic bubbles’, which suggests that this type of rational bubble depends exclusively on the exogenous fundamental determinant of asset value. In essence, Froot and Obstfeld suggest that the ‘bubble’ element in prices is constant if the fundamental determinant is constant but will change in a non-linear way along with the level of the fundamental determinant. Intrinsic bubbles therefore not only have the property of being periodically collapsing, they also capture the idea that asset prices overreact to news on fundamental factors.

In common with rational explosive bubbles, intrinsic bubbles rely on bounded rationality and self fulfilling expectations. However, unlike rational explosive bubbles, such bubbles do not continuously diverge but periodically revert toward their fundamental value. Essentially, like explosive bubbles, the existence of intrinsic bubbles also violates the transversality condition that the expected asset price goes to zero as time goes to infinity but, with the latter, agents will eventually learn that their expectations regarding fundamental realizations are unreasonable and will revise their expectations.

5.2 Tests of Rational Bubbles

Given the properties of rational explosive bubbles, Diba and Grossman (1988) suggest a bubble detection method based on cointegration tests. In the presence of a rational explosive bubble these variables all have an explosive conditional expectation:

$$\lim_{K\to\infty}\left(1/(1+R)^K\right)\mathrm{E}_t\left[X_{t+K}\right]\neq 0 \; for \quad X_t = P_t, \Delta P_t, P_t - D_t/R \tag{19}$$

In other words, the term $P_t - D_t / R$ implies that these two processes, fundamental factors D_t and stock prices P_t, should be cointegrated, when the market is efficient and the present-value model holds. The cointegration test results reported in Table 7 support a long-run stable relationship between prices and dividends for all markets in the sample ~ a feature which does not lend support for the rational explosive bubble explanation of deviations from fundamental values.[7] We therefore consider the 'rational intrinsic bubble' explanation for these deviations.

We begin first by recalling from earlier discussions that the traditional present value model can be displayed in a similar form to equation (8) but incorporating different assumptions regarding the behavior of $\mu^i pc_{t+i}$ as $i \to \infty$:

$$pc_t = \frac{k(1-\mu^i)}{(1-\mu)} + \sum_{j=0}^{i-1}\mu^{j+1}\Delta c_{t+j+1} - \sum_{j=0}^{i-1}\mu^{j+1} r_{t+j+1} + \mu^i pc_{t+i} \tag{20}$$

By assuming the limit of the last term in (8) was zero and utilizing the VAR model, we were able to derive the fundamental value of the logged price/cash flow ratio's. However, if the limit of $\mu^i pc_{t+i}$, is non-zero, then equation (20) is a solution to the present value model but one which violates the transversality condition imposed on equation (8). In such a case, if we substitute the first three terms on the right hand side of equation (20) with the fundamental logged price/cash flow ratio and rearrange, this equation becomes:

$$pc_t - pc_t^* = b_t \tag{21}$$

where $b_t = \mu^i pc_{t+i}$, and the price deviation component is explained in terms of differences between actual and fundamental logged price/cash flow ratios

How then might we empirically measure the extent of any intrinsic bubble inherent in stock prices? Building on the work of Froot and Obsfeld (1991) assuming that real cash flows follow an autoregressive process with drift, we hypothesize that the intrinsic bubble is a non-linear function of cash flows, therefore:

$$B_t = \kappa C_t^{\lambda} \tag{22}$$

where κ is a constant $(\kappa > 0)$, C_t denotes real cash flows and λ is the exponent greater than 1 that reflects the characteristic of an intrinsic bubble resulting from investors overreaction to fundamental factors.

The mean-reverting characteristic of intrinsic bubbles implies a long term relationship between prices and fundamentals. To tie the bubble to the fundamentals, we assume that logged cash flows, denoted by c_t, follow a random walk with drift parameter, μ:

$$c_{t+1} = \mu + c_t + \xi_{t+1} \tag{23}$$

where $\xi_{t+1} \sim N(0, \sigma^2)$. In order to satisfy the fair game property of rational bubbles, the exponent λ should be the (positive) root of

$$\lambda^2 \sigma^2 / 2 + \lambda\mu - r = 0 \tag{24}$$

therefore permitting the bubble to grow in expectation rate of e^r.

Dividing both sides of equation (22) by C_t, we can transform the bubble component and display it in the form of price/cash flow ratio:

$$B_t / C_t = \kappa C_t^{\lambda-1} \tag{25}$$

Taking logs of each side and then substituting it into (21) allow us to specify a logged linear regression of the form:

$$pc_t - pc_t^* = \kappa' + (\lambda - 1)c_t' + \varepsilon'_t \tag{26}$$

where κ' is the logged value of κ and ε'_t is the regression error term, and lower case letters denote logs. The exponent of the fitted values of (26) then permits the construction of the intrinsic bubble series B_t which mimics the path the bubble takes overtime. When the bubble series $B_{t,}$ is combined with P_t^* as $P_t^* + B_t$, we have a price series which includes an intrinsic bubble that can be compared to actual prices, P_t .

In Figure 2, each of the associated dividend and earnings graphs depict three price series for Hong Kong and Singapore: the actual stock price series, P_t, the fundamental stock price series, P_t^*, and the price series that includes both the fundamental price and bubble component, $P_t^* + B_t$. The intrinsic bubble model however does not appear to significantly improve the present value model in its ability to track actual prices. The results therefore suggest little evidence that investors overreact to information on fundamental factors in the Hong Kong and Singapore markets.

The (heteroskedasticity and autocorrelation robust) regression results support this view drawn from inspection of the graphs and are shown in Table 8. For both the dividend and earnings models in the Hong Kong market, while the κ (the exponent of κ') supports the existence of price deviations from fundamentals, the regression $\overline{R}^2$ is low, suggesting that overreaction to news on fundamental factors is not a major source of price deviations. More importantly, although the coefficient λ is greater than 1, its 95% confidence interval does not include the positive root of equation (24), i.e. $\hat{\lambda}$. The price deviation therefore is not a rational phenomenon, since the model does not satisfy the fair game property inherent in rational intrinsic bubbles. For the Singaporean market, the graphs and the regression results are similar to those of Hong Kong. Overall the empirical results suggest that the rational intrinsic bubble model fails to explain the revealed price deviations in these markets.

6. Concluding Remarks

The dramatic rise and subsequent collapse of stock markets, particularly from the 1980s, have led many to question whether stock markets operate rationally. An attempt to investigate this issue inevitably prompts two questions: What are the fundamental values of stocks? If stock prices deviate from their fundamental value, what type of investor behavior can account for any revealed sustained price deviations?

Recognizing the rejections of the simple present value model, we utilized a 'dynamic' present value model to estimate fundamental stock values for a range of developed and Asian emerging stock markets. We considered two publicly available fundamental factors, namely narrowly defined index cash dividends and the broader measure of index earnings. The reported results suggest that the publicly available expected earnings series have significant power in driving stock prices in the markets of the U.S., U.K., Japan, Korea and Malaysia, while publically available expected dividends have relatively more influence on the indices of Thailand, Taiwan and Indonesia. The success of the dynamic present value model in explaining actual price movements in these markets would indicate that rational investors, who drive markets towards optimality and efficiency, are dominant and that prices respond to publically available information. This also implies that investors will adjust their expected returns, and accordingly discount rates will tend to vary over time.

Interestingly, neither the earnings series nor the dividend series can explain the time path of stock prices in the Hong Kong and Singaporean markets. To further investigate this we considered the existence of rational bubbles in these markets. The results suggested that the revealed price deviations were unlikely to be driven either by rational explosive bubbles or by rational intrinsic bubbles, namely investor overreaction to news on fundamentals regarding dividends and earnings.

Future work on unexplained price deviations can also be considered from the viewpoint of prolonged deviations from fundamental value being due to irrational momentum-type investor behavior. Culter et al. (1990), for example, develop an 'asset pricing dynamics' model that incorporates the interaction between feedback traders and rational traders. In this model, returns over a short horizon are positively serially correlated, which implies buying short term 'winners' and short-selling short term 'losers' would yield more winnings. Daniel et al. (1998) also argue that the investor psychology of biased self-attribution, where informed traders attribute the ex-post short term winners to superior skill and ex-post losers to bad luck, adds positive short-lag autocorrelation (momentum) and short-run earnings 'drift'. We place this on the agenda for future research.

Notes:

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[1] See Barberis and Thaler, 2003, for a survey of behavioral finance.

[2] See Campbell and Viceira (1999) and Chordia and Shivakumar (2002) for a discussion of the validity as to whether investors expect time-varying returns.

[3] It should be noted however that both the dividend and earnings series cannot fully represent the 'true' dividend-paying ability of companies: the dividend series is essentially a 'managed' series, while the earnings series encounters the 'double counting' problem when creating the intrinsic value of asset.

[4] While we use Treasury Bill rates as the risk-free rate proxy for the U.S, U.K., Singapore and Malaysia markets, these rates were not available for the remaining markets. We therefore followed the approach adopted by Harvey (1994), and used the 'most unregulated' rates. Thus for Hong Kong, Taiwan and Indonesia, we use the 3 month interbank rate while for Japan, Korea and Thailand, money market rates are used.

[5] See Table 7 and the discussion in section 5 for the implications of cointegration with respect to the existence of rational explosive bubbles.

[6] The *CRRA* for the markets of Korea and Indonesia differ according to which model (dividend or earnings) is estimated. This is a consequence of a re-adjustment of the sample period analysed for these two markets, with the adjustment due to the shorter availability of earnings data (see notes to Table 5).

[7] Cointegration results were qualitatively similar to those reported when dividends were replaced by earnings.

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Table 1: Markets and Sample Periods

Market	***Sample Period***
U.S.	January, 1973 - July, 2006
U.K.	January, 1965 - July, 2006
Hong Kong	January, 1984 - July, 2006
Japan	January, 1973 - July, 2006
Singapore	April, 1973 - July, 2006
Korea	October, 1987 - July, 2006
Malaysia	January, 1986 - July, 2006
Thailand	January, 1987 - July, 2006
Taiwan	May, 1988 - July, 2006
Indonesia	April, 1990 - July, 2006

Table 2: Summary Statistics for Monthly Real Gross Returns, Real Safe Rates, Dividends and Earnings*

	U.S.	***U.K.***	***Hong Kong***	***Japan***	***Singapore***	***Korea***	***Malaysia***	***Thailand***	***Taiwan***	***Indonesia***
Returns										
Mean	0.005	0.006	0.010	0.003	0.003	0.003	0.007	0.007	0.002	-0.004
S.D.	0.044	0.055	0.083	0.051	0.080	0.093	0.084	0.104	0.111	0.101
Safe Rate										
Mean	0.001	0.002	0.001	0.001	-1.32E-05	0.004	0.002	0.002	0.002	0.004
S.D.	0.003	0.006	0.007	0.006	0.007	0.006	0.003	0.005	0.009	0.013
Sharp Measure	0.084	0.078	0.107	0.027	0.041	-0.010	0.069	0.043	-0.001	-0.089
Dividends										
Mean	0.244	0.532	1.025	0.104	0.177	0.139	0.601	0.661	0.146	0.054
S.D.	0.039	0.155	0.298	0.013	0.055	0.043	0.139	0.298	0.078	0.022
C.V.	15.768	29.038	29.084	12.958	31.264	31.298	23.188	45.090	53.225	40.976
Earnings										
Mean	0.589	0.963	2.235	0.282	0.403	0.536	1.383	1.802	0.417	0.196
S.D.	0.193	0.265	0.776	0.070	0.193	0.230	0.518	0.773	0.173	0.058
C.V.	32.753	27.505	34.735	24.869	47.857	42.828	37.425	42.921	41.563	29.422

* S.D. denotes standard deviation. For the Korean and Indonesian markets, earnings data were available from January 1988 and February 1991 respectively. C.V. denotes the coefficient of variation, which is defined as standard deviation divided by mean and multiplied by 100.

Table 3: Unit Root Test for Variables in the VAR Model

	U.S.	***U.K.***	***Hong Kong***	***Japan***	***Singapore***	***Korea***	***Malaysia***	***Thailand***	***Taiwan***	***Indonesia***
Logged price/dividend ratio	-3.164 (0.093)	-3.112 (0.104)	-3.618 (0.030)	-1.379 (0.593)	-4.133 (0.006)	-3.463 (0.009)	-2.639 (0.086)	-2.397 (0.143)	-2.842 (0.183)	-3.011 (0.035)
Logged price/earnings ratio	-3.404 (0.052)	-2.510 (0.322)	-3.462 (0.045)	-1.610 (0.476)	-4.392 (0.002)	-3.429 (0.050)	-3.877 (0.014)	-3.712 (0.023)	-2.863 (0.176)	-3.154 (0.097)
Dividend growth	-18.790 (0.000)	-23.589 (0.000)	-16.956 (0.000)	-18.153 (0.000)	-20.128 (0.000)	-12.410 (0.000)	-14.245 (0.000)	-12.377 (0.000)	-13.273 (0.000)	-16.094 (0.000)
Earnings growth	-20.142 (0.000)	-22.137 (0.000)	-14.986 (0.000)	-16.127 (0.000)	19.485 (0.000)	-13.687 (0.000)	-15.801 (0.000)	-13.802 (0.000)	-13.625 (0.000)	-12.475 (0.000)
σ^2_t	-17.445 (0.000)	-19.649 (0.000)	-16.626 (0.000)	-18.986 (0.000)	-17.760 (0.000)	-16.637 (0.000)	-14.394 (0.000)	-15.216 (0.000)	-14.688 (0.000)	-12.080 (0.000)

The unit root test is performed by the Phillips-Perron statistic, with bandwidth selected by Newey-west using a Bartlett kernel. σ^2_t is the variance of the excess stock return series. Figures in parentheses below the pp statistics are marginal significance levels.

Table 4: VAR Statistics for the Developed Markets

Fundamental and Markets	α	***p***	z_t	$\overline{R}^2$	**Q**
Dividends: U.S.	2.514	2	pc_t	0.993	2.843 (0.828)
			Δc_t	0.057	5.334 (0.502)
			σ^2_t	0.080	2.453 (0.874)
Earnings: U.S.		3	pc_t	0.987	8.981 (0.175)
			Δc_t	0.268	4.205 (0.649)
			σ^2_t	0.106	1.069 (0.983)
Dividends: U.K.	1.873	3	pc_t	0.958	5.108 (0.530)
			Δc_t	0.087	0.759 (0.993)
			σ^2_t	0.140	1.620 (0.951)
Earnings: U.K.		3	pc_t	0.975	3.463 (0.749)
			Δc_t	0.114	5.703 (0.457)
			σ^2_t	0.139	1.649 (0.949)
Dividends: Hong Kong	1.683	1	pc_t	0.895	4.604 (0.595)
			Δc_t	0.035	3.382 (0.760)
			σ^2_t	0.035	0.543 (0.997)
Earnings: Hong Kong		1	pc_t	0.885	11.114 (0.085)
			Δc_t	0.073	8.696 (0.191)
			σ^2_t	0.034	0.647 (0.996)
Dividends: Japan	1.102	5	pc_t	0.990	1.175 (0.978)
			Δc_t	0.152	4.873 (0.560)
			σ^2_t	0.156	3.434(0.753)
Earnings: Japan		6	pc_t	0.987	2.502 (0.868)
			Δc_t	0.261	2.810 (0.832)
			σ^2_t	0.189	0.119 (0.995)
Dividends: Singapore	1.172	2	pc_t	0.992	3.989 (0.678)
			Δc_t	0.049	4.097 (0.664)
			σ^2_t	0.068	7.007 (0.320)
Earnings: Singapore		2	pc_t	0.887	3.190 (0.785)
			Δc_t	0.068	3.640 (0.725)
			σ^2_t	0.006	7.590 (0.270)

α is the coefficient of relative risk aversion (*CRRA*) imposed on the model. p is the lag length for the VAR model. z_t denotes the variables vector. pc_t is the logged price/cash flow ratio, Δc_t is the real cash flow growth rate, and σ^2_t is the variance of the stock return series. $\overline{R}^2$ is the coefficient of determination adjusted for lag length. The Q statistic is the Ljung-Box test statistics for significance of up to the sixth autocorrelation coefficient. Figures in parentheses alongside the Q statistics are marginal significance levels.

Table 5: VAR Statistics for the Developing Markets

Fundamental and Markets	α	***p***	z_t	$\overline{R}^2$	***Q***
Dividends: Korea	0.377	2	pc_t	0.851	1.462 (0.962)
			Δc_t	0.197	2.497 (0.869)
			σ^2_t	0.237	4.658 (0.588)
Earnings: Korea	(0.293)	2	pc_t	0.865	3.009 (0.808)
			Δc_t	0.104	2.131 (0.907)
			σ^2_t	0.236	3.933 (0.686)
Dividends: Malaysia	1.337	3	pc_t	0.946	4.694 (0.584)
			Δc_t	0.142	7.423 (0.283)
			σ^2_t	0.177	4.265 (0.641)
Earnings: Malaysia		3	pc_t	0.909	1.337 (0.970)
			Δc_t	0.170	0.240 (1.000)
			σ^2_t	0.183	5.156 (0.524)
Dividends: Thailand	0.915	2	pc_t	0.944	10.241 (0.115)
			Δc_t	0.220	3.748 (0.711)
			σ^2_t	0.111	7.068 (0.315)
Earnings: Thailand		2	pc_t	0.807	1.404 (0.996)
			Δc_t	0.158	5.469 (0.485)
			σ^2_t	0.010	7.850 (0.249)
Dividends: Taiwan	0.462	3	pc_t	0.932	2.719 (0.843)
			Δc_t	0.117	6.405 (0.379)
			σ^2_t	0.366	9.565 (0.144)
Earnings:Taiwan		3	pc_t	0.931	3.103 (0.796)
			Δc_t	0.142	3.163 (0.788)
			σ^2_t	0.371	7.532 (0.274)
Dividends: Indonesia	-0.356	3	pc_t	0.941	1.160 (0.979)
			Δc_t	0.248	6.108 (0.411)
			σ^2_t	0.197	3.580 (0.733)
Earnings: Indonesia	(-0.161)	3	pc_t	0.892	4.124 (0.660)
			Δc_t	0.156	1.301 (0.972)
			σ^2_t	0.207	4.468 (0.614)

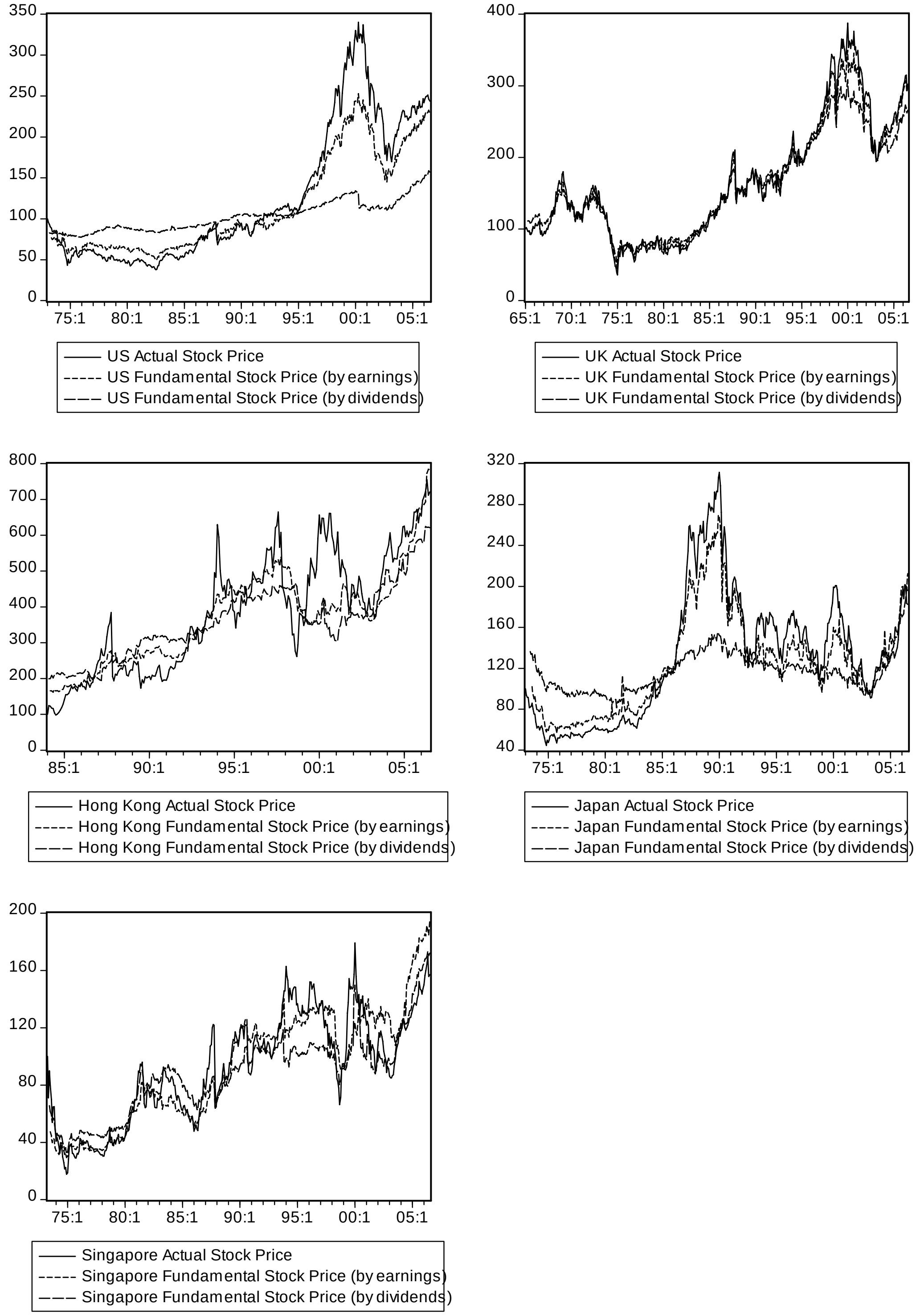
α is the coefficient of relative risk aversion (*CRRA*) imposed on the model. p is the lag length for the VAR model. z_t denotes the variables vector. pc_t is the logged price/cash flow ratio, Δc_t is the real cash flow growth rate, and σ^2_t is the variance of the stock return series. $\overline{R}^2$ is the coefficient of determination adjusted for lag length. The Q statistic is the Ljung-Box test statistics for significance of up to the sixth autocorrelation coefficient. Figures in parentheses alongside the Q statistics are marginal significance levels. Due to the availability of earnings data, the sample period for Korea and Indonesia was shorter than that using dividend data. For the former, the sample period was January 1988 through July 2006 while for the latter it was February 1991 through July 2006.

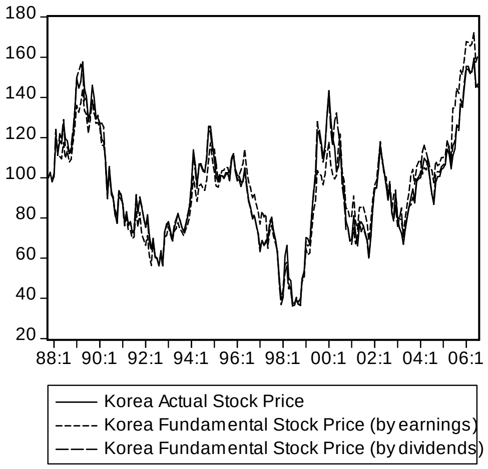
Table 6: Non-linear Wald Tests

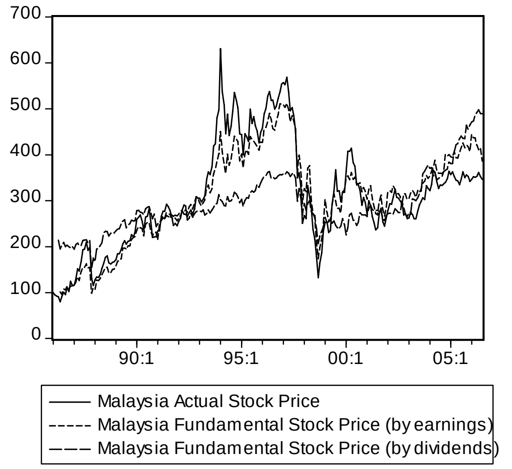
Fundamental and Markets	***Restrictions***	***Non Linear Wald Test***
The Developed Markets		
Dividends: U.S.	6	52.899 (0.000)
Earnings: U.S.	9	15.849. (0.071)
Dividends: U.K.	9	26.957. (0.001)
Earnings: U.K.	9	16.674. (0.054)
Dividends: Hong Kong	3	36.476 (0.000)
Earnings: Hong Kong	3	18.236 (0.000)
Dividends: Japan	15	51.912 (0.000)
Earnings: Japan	18	20.730 (0.293)
Dividends: Singapore	6	38.273 (0.000)
Earnings: Singapore	6	53.732 (0.000)
The Developing Markets		
Dividends: Korea	6	15.873 (0.014)
Earnings: Korea	6	8.952 (0.176)
Dividends: Malaysia	9	40.992 (0.000)
Earnings: Malaysia	9	19.483 (0.021)
Dividends: Thailand	6	14.561. (0.024)
Earnings: Thailand	6	19.132 (0.004)
Dividends: Taiwan	9	18.959 (0.026)
Earnings: Taiwan	9	23.649 (0.005)
Dividends: Indonesia	9	19.789 (0.019)
Earnings: Indonesia	9	24.220 (0.004)

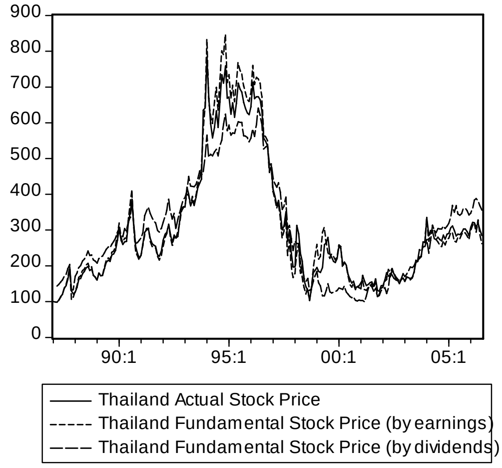
The Wald test restrictions imposed on the VAR are given by the number of variables times the lag length (i.e. $3 \times p$). The null for the non-linear Wald test is that the actual and fundamental logged price/earnings ratio's are the same. Parentheses alongside the reported Wald statistics are the marginal significance levels.

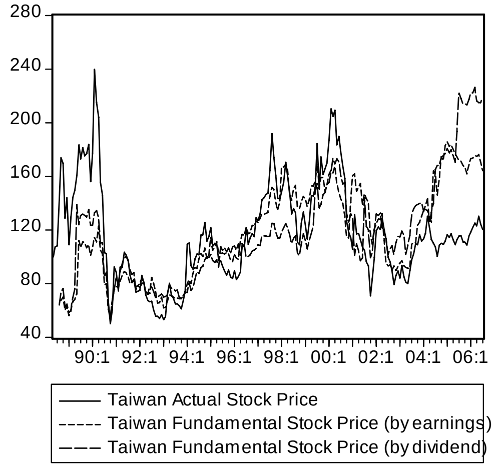
Figure 1: Actual and Fundamental Real Stock Price Indices




180
160
140
120
100
80
60
40
20
88:1 90:1 92:1 94:1 96:1 98:1 00:1 02:1 04:1 06:1
Korea Actual Stock Price
Korea Fundamental Stock Price (by earnings)
Korea Fundamental Stock Price (by dividends)


700
600
500
400
300
200
100
0
90:1 95:1 00:1 05:1
Malaysia Actual Stock Price
Malaysia Fundamental Stock Price (by earnings)
Malaysia Fundamental Stock Price (by dividends)


900
800
700
600
500
400
300
200
100
0
90:1 95:1 00:1 05:1
Thailand Actual Stock Price
Thailand Fundamental Stock Price (by earnings)
Thailand Fundamental Stock Price (by dividends)


280
240
200
160
120
80
40
90:1 92:1 94:1 96:1 98:1 00:1 02:1 04:1 06:1
Taiwan Actual Stock Price
Taiwan Fundamental Stock Price (by earnings)
Taiwan Fundamental Stock Price (by dividend)


100
90
80
70
60
50
40
30
20
10
92:1 94:1 96:1 98:1 00:1 02:1 04:1 06:1
Indonesia Actual Stock Price
Indonesia Fundamental Stock Price (by earnings)
Indonesia Fundamental Stock Price (by dividends)

Table 7: Johansen Cointegration Tests Between Stock Prices and Dividends

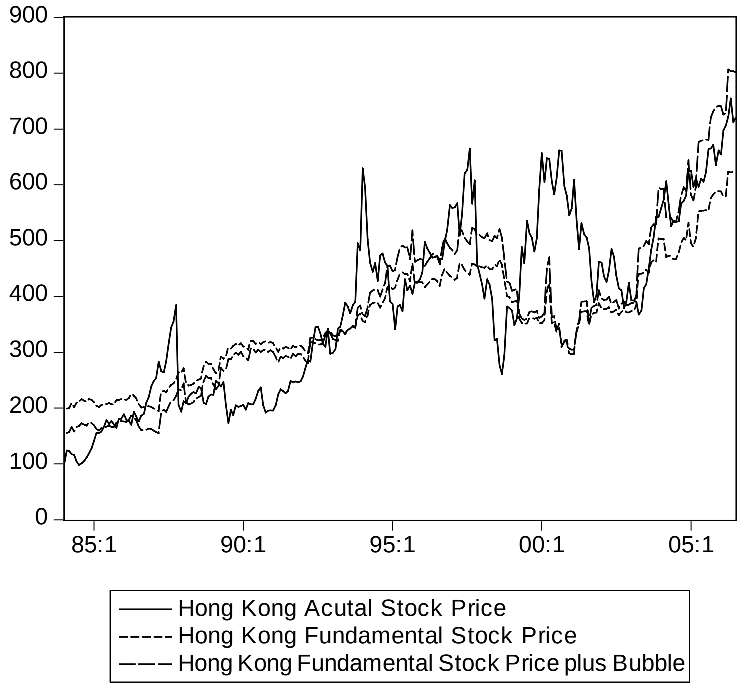
Market	***r***	***Eigen-value***	***Trace Statistic***	***0.05 Critical Value***	***0.01 Critical Value***	***Max-Eigen Statistic***	***0.05 Critical Value***	***0.01 Critical Value***
U.S.	None	0.039099	16.89105	15.41	20.04	16.03352	14.07	18.63
	At most 1	0.002131	0.857534	3.76	6.65	0.857534	3.76	6.65
U.K.	None	0.031677	15.97925	15.41	20.04	15.93379	14.07	18.63
	At most 1	9.18E-05	0.045458	3.76	6.65	0.045458	3.76	6.65
Hong Kong	None	0.052929	20.98395	19.96	24.6	14.30228	15.67	20.2
	At most 1	0.025086	6.681666	9.24	12.97	6.681666	9.24	12.97
Japan	None	0.060392	28.14665	25.32	30.45	25.04143	18.96	23.65
	At most 1	0.007695	3.105227	12.25	16.26	3.105227	12.25	16.26
Singapore	None	0.041616	17.10744	15.41	20.04	16.87533	14.07	18.63
	At most 1	0.000585	0.232115	3.76	6.65	0.232115	3.76	6.65
Korea	None	0.081556	21.64399	19.96	24.6	19.14178	15.67	20.2
	At most 1	0.011059	2.502207	9.24	12.97	2.502207	9.24	12.97
Malaysia	None	0.111089	31.79672	25.32	30.45	23.90483	18.96	23.65
	At most 1	0.03813	7.891889	12.25	16.26	7.891889	12.25	16.26
Thailand	None	0.072722	22.82201	19.96	24.6	16.38382	15.67	20.2
	At most 1	0.029233	6.438193	9.24	12.97	6.438193	9.24	12.97
Taiwan	None	0.074079	19.7345	19.96	24.6	16.08604	15.67	20.2
	At most 1	0.017305	3.648462	9.24	12.97	3.648462	9.24	12.97
Indonesia	None	0.093561	21.9143	19.96	24.6	18.95872	15.67	20.2
	At most 1	0.015197	2.955579	9.24	12.97	2.955579	9.24	12.97

r is the number of cointegrating vectors under the null hypothesis. The critical values are taken from Osterwald-Lenum (1992).

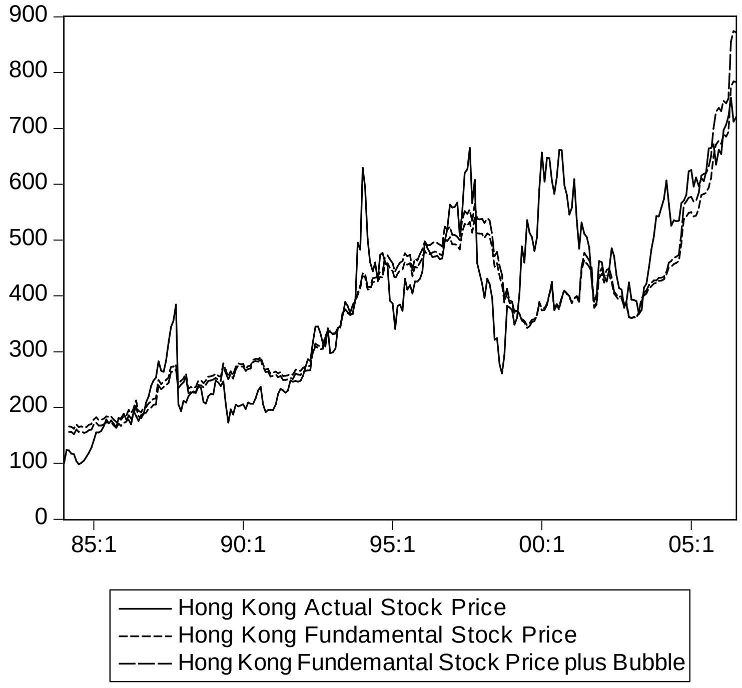
Figure 2: Actual Prices, Intrinsic Bubble Prices and Fundamental Prices

A. Hong Kong

1. Fundamentals Constructed from Dividends

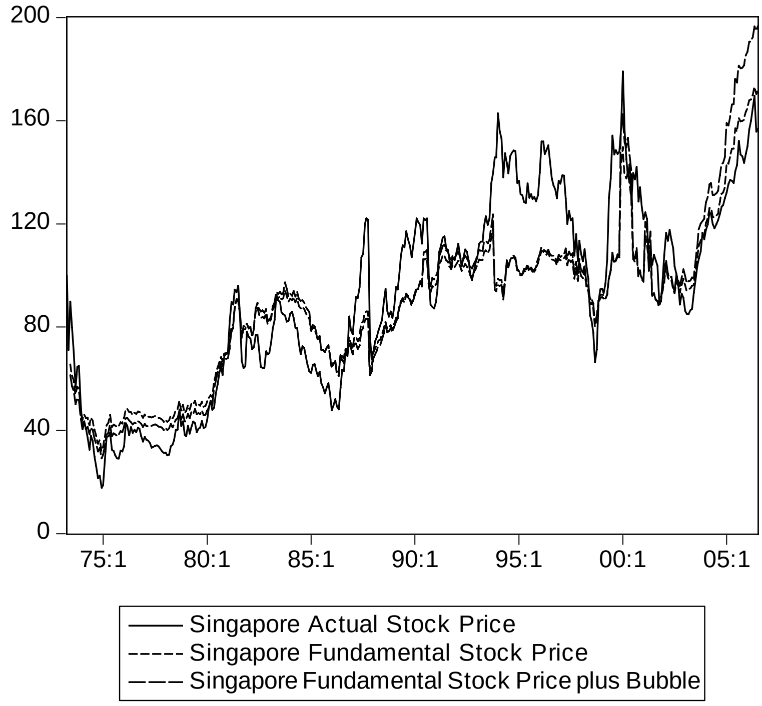


2. Fundamentals Constructed from Earnings



B. Singapore

1. Fundamental Constructed from Dividends



2. Fundamentals Constructed from Earnings

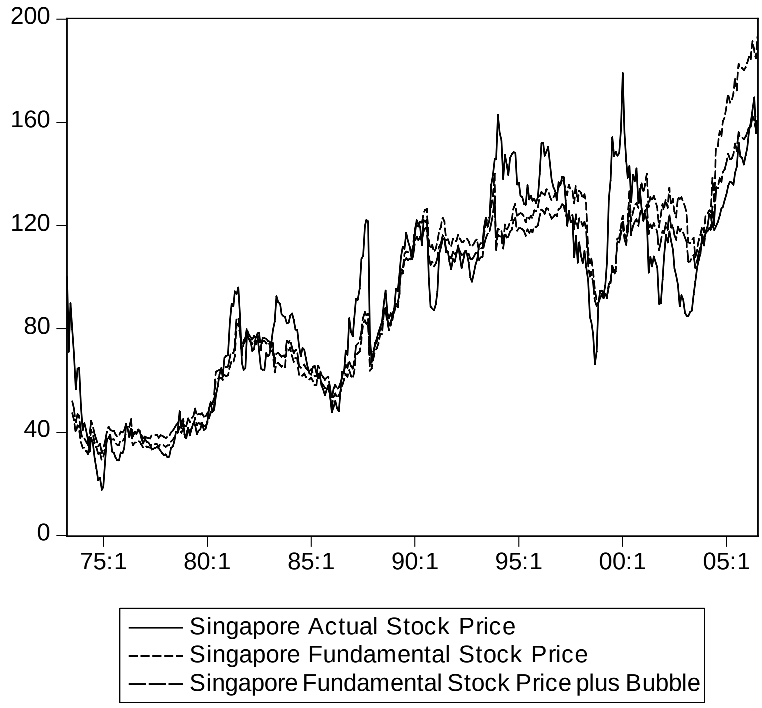


Table 8: Regression of Deviations from Present Value on Dividends

$$pc_t - pc_t^* = \kappa' + (\lambda - 1)c_t + \varepsilon'_t$$

Market	κ'	$\lambda - 1$	$\overline{R}^2$	$\hat{\lambda}$
Hong Kong				
(a) d_t = dividends	0.0098 (0.0328)	0.4201 (0.0985)	0.1871	1.92
(b) d_t = earnings	-0.1445 (0.0935)	0.2386 (0.1378)	0.0289	3.32
Singapore				
(a) d_t = dividends	0.3053 (0.1202)	0.1725 (0.0686)	0.0699	0.87
(b) d_t = earnings	0.1656 (0.0480)	-0.6741 (0.1579)	0.1750	2.95

$pc_t - pc_t^*$ denotes the difference between fundamental and actual logged price/cash flow ratio, c_t denotes logged real cash flow, and ε'_t is the error term of the regression. κ', λ are the parameters of interest with the figures in parenthesis below the coefficient estimates being Newey-West standard errors. $\overline{R}^2$ denotes the coefficient of determination and $\hat{\lambda}$ is the positive root of $\lambda^2\sigma^2/2 + \lambda\mu - r = 0$, given the rational intrinsic bubble is expected to have a long term growth rate of e^r.