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Long-Term Trends and Short-Run Dynamics in International Stock Markets

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Abstract

The objective of the present study is to examine the behaviour and interaction of international stock markets. The validity of an earnings based valuation model is assessed using data from seventeen developed countries around the world over the last sixteen years. The estimation process employed involves a two–step Engel–Granger procedure where cointegrating relationships between market indices and their fundamentals are analysed. Cointegration appears mainly in large markets, while the presence of an error correction representation implies the existence of the reversion force towards the fair value obtained from the cointegrating regression. Further, the error correction model, enriched with other variables identified in previous research, seems to capture the short–run dynamics quite well. The coefficients of the variables in both the cointegrating regression and the error correction representation have the correct signs and are consistent in size. Granger causality tests do not particularly support the hypothesis that smaller markets are being influenced by external factors, since causality seems to run both from large to small markets and vice versa.

Key Words: International markets, Market indices, Cointegration, Error correction model, Short-run dynamics, Causality.
JEL: C22, C52, G15

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I. Introduction

Stock market movements have been the focus of empirical research for many years. One strand of the existing literature examines whether the intrinsic value calculated from theoretical models can adequately explain the evolution of stock prices. Such models have been extensively tested in the literature, both directly and as part of the tests for market efficiency[1]. Another approach to modelling stock markets is to search for stable empirical relationships between the market and variables that are assumed to drive it and are not necessarily theoretically founded. In this context, the explanatory power of dividend yield, macroeconomic variables or investment rates has been evaluated [Chen *et.al.* (1986), Renshaw (1997)]. On a firm basis, stock returns have been related to firm characteristics such as size, book to market value, price to earnings ratios etc. Though the second approach suffers from weaker theoretical grounding and may seem a somewhat arbitrary empirical exercise, it avoids the drawback of being based on theoretical assumptions that hardly apply in reality. In this paper we manage to endorse both approaches within the context of an earnings-based valuation model.

The dividend based valuation model has been extensively tested at an index level, but results have not been encouraging since various papers have found inconclusive results [LeRoy & Porter (1981), Shiller (1981), Campbell & Shiller (1987), MacDonald & Power (1995)]. This paper employs an earnings based valuation model along the lines of Harasty & Roulet (2000) to explain the behaviour of seventeen advanced stock markets, using the two-stage econometric model of Engle & Granger (1987). The implicit assumption in the model is that stock prices can be decomposed into a permanent

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[1] [1] For example, Fama & French (1988) test the Gordon Growth model to assess whether dividend yields and interest rates can adequately predict stock returns. LeRoy & Porter (1981), Shiller (1981), Campbell & Shiller (1987), MacDonald & Power (1995), and Harasty & Roulet (2000) among others have formulated tests of the dividend based valuation model.

and transitory component as first suggested by Beveridge & Nelson (1982). The permanent (nonstationary) component is the long-run trend of the market, which is interpreted to be its fair value. Stock prices should then be cointegrated with their fundamentals according to the proposed theoretical model. It is actually this long-run trend, which can be regarded as a process of random walk with drift [Amihud & Mendelson (1987)][2]. On the other hand, there is empirical support for stock prices following a mean reversion process, which could be attributed to market microstructure effects such as non-synchronous trading [Campbell, Lo & MacKinlay (1997)][3]. The transitory (stationary) component represents short-run deviations from trend, which may be caused by variables that do not enter the theory and thus have to be fitted empirically. An Error Correction Model (ECM) is employed to explain fluctuations of the market around this fair value. This methodological approach is in line with the evidence of mean reversion in stock index prices over long horizons in Poterba & Summers (1988), Fama & French (1988a) and Balvers, Wu & Gilliland (2000).

The Cointegarion - Error Correction formulation of the earnings-based model is useful on a number of grounds. First, the salient feature of stock prices, that is, the tendency to revert to a long-term mean, is modelled explicitly. Standard unit root tests show that the trend is stochastic, which according to the underly-

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2 Security returns, however, do not follow a process that has all the properties of a random walk [Copeland & Weston (1992)]. This makes sense because the condition that the entire underlying probability distribution of returns remain stationary through time is simply too strong. It is actually empirically established that changes in the business risk will result to changes in the variance of the stock.

3 Debond & Thaler (1987) find a mean reversion pattern of earnings and stock prices. Black (1993) notes that such mean reversion may be regarded as a confirmation of market efficiency if accounting numbers reflect corporate fundamentals with a lag, as has been suggested by Beaver et al. (1980). Nevertheless, such discussion is beyond the scope of the present study and the interesting reader should refer to the relevant literature.

ing theory could derive from stochastic growth components in earnings and dividends. Moreover, the paper tests whether there is a valid statistical relationship between prices, earnings, and interest rates, instead of just assuming that it exists [Kasa (1992)]. Another important advantage of the proposed methodology is the focus on equity prices rather than equity returns. Engle & Granger (1997) demonstrate that if a vector of time series shares a common trend, then models which ignore this trend by only incorporating first differences (thus transforming prices into returns) suffer at minimum a loss of efficiency and are probably subject to more serious specification biases as well. The majority of studies on mean reversion fail to specify a fundamental value path for the asset under investigation by first differencing the price series, at the cost of losing information that would otherwise aid in identifying a mean-reverting price component. The methodology employed allows us to model stock prices and to incorporate the long-run information in the study of short-term dynamics.

Furthermore, it has been argued that deregulation and liberalization of different markets, the relaxation of capital controls and the increase in the international activities of multinational corporations have probably induced long-run relationships between the stock prices of different countries [Blackman *et. al*. (1994)]. Thus, the paper tests whether the larger markets Granger cause the markets in which earnings seem to have a weaker impact. Evidence in favour of Granger causality can also be interpreted in terms of a portfolio diversification perspective; if shocks are transmitted between markets, then there are little long-term gains to international diversification.

In what follows, section II presents the model used in the estimation process and section III describes the data and the methodology employed. In section IV and V the necessary tests and the empirical evidence for the cointegration, short-run dynamics and causality analysis are presented. Finally, in section VI summarises our results, draws some conclusions and points out areas of future research.

II. Modelling Stock Prices

It is theoretically established that prices can be expressed in terms of dividends and/or other macroeconomic variables. Dividend based valuation models have been widely tested in the finance literature but results remain conflicting [MacDonald & Power (1985), Campbell & Schiller (1987), Fama & French (1988b)]. Prices can also be expresses as a function of earnings, the payout ratio, a certain growth rate and a discount factor reflecting the friskiness of the firm. Note, however, that the equilibrium price is sensitive to changes in the constituents of the discount factor.

Theoretically, the risk free rate mirrors the expected future short–term rates, which are not observable. Therefore, the current long–term yield is generally used as a proxy on the assumption that it incorporates all expectations of future yields. The risk premium is even more difficult to determine. Since we are trying to calculate the intrinsic value of the market, an “equilibrium” risk premium must be used. This implies that the previous period’s risk premium is not suitable as it retraces the impact of short–run factors such as investor sentiment, seasonality etc. [Harasty & Roulet (2000)]. Alternatively, the average historical implied risk premium over one or more complete price “cycles” could be employed (i.e. periods of time during which the market has deviated from and returned to its intrinsic value). However, this implies that certain non–trivial assumptions regarding price behaviour apply a priori, namely that a) stock prices revert to their intrinsic value, and b) the market has been in equilibrium, on average, during the period studied. Due to the above considerations, we choose to use the current long–term yield and a constant risk premium that we do not impose a priori. Thus, the proposed stock price model becomes:

$$P_t = \frac{k\, E_t\, (1+g)}{y_t + r_p - g} \tag{1}$$

where P_t = price of the stock/index at time t

E_t = earnings at time t

k = payout ratio

y_t =current long-term yield at time t

r_p = risk premium

g = growth rate

In order to empirically test the above equation, we take the logarithms of both earnings and prices and use a simplified expression for the discount rate. Then, our model takes the following form:

$$\ln(P_t) = \alpha + \beta_1 \ln(E_t) + \beta_2 y_t + u_t \tag{2}$$

To be consistent with the dividend based valuation model, the estimated constant term α should be close to $ln(1+g) + ln(k)$. Coefficient β_1 represents the elasticity of stock prices with respect to earnings and is expected to be positive, while β_2 the semi-elasticity of prices to market yields and is expected negative. At this stage one could argue that $r_p - g$ is not explicitly taken into account, but we have assumed that both are constant over time. Even though a large part of short-run price fluctuations are due to changes in the required risk premium, they should not affect the intrinsic value as long as they are not structural. From an econometric standpoint equation (2) is preferable to equation (1) as it allows us to measure the semi-elasticity of prices to market yields. Harasty & Roulet (2000) actually show that the dividend based valuation formula produces very unrealistic price movements when yields decrease to low levels.

Consequently, the paper models stock markets in two distinctive phases: first, it estimates the intrinsic value, and next deviations from that value. The market's intrinsic value is estimated through equation (2), while to capture deviations from equilibrium we introduce variables other than earnings and long-term rates that are likely to signal shifts in the risk premium attached to market returns. Such variables include exchange rates, short-term interest rates, the spread between domestic and foreign rates and few others presented and analysed in section V.

III. Data and Methodology

In this section we present the data employed, some statistics and the time period that cover our sample. We also describe the econometric framework used to estimate the suggested model.

Data

End-of-month 'Total Market' indices from various developed countries are employed. These are Datastream calculated series, which do not include all companies in the market but consist of companies according to their size of market capitalization. Earnings at an index level are calculated simply by dividing the index with the price-earnings ratio provided by Datatstream. Twelve-month forward earnings are used throughout, as in Harasty and Roulet (2000), on the assumption that investors scrutinize firms' results on a one-year horizon. Local currency indices were also used in order to avoid exchange rate induced effects and, thus, any co-movements between prices and earnings do not reflect a common change in value due to exchange rate fluctuations. For the long-term yields the 10-year government bond is employed[4].

The data set employed consists of monthly data and spans various periods between 1984 and 2000. The starting date of our sample period varies from country to country according to data availability. We aim to use as much information as possible to avoid small-sample biases and, thus, we do not restrict ourselves to a common estimation period for the whole group of countries. Details of the starting estimation date for each country, common to

[4] [4] Since there is no a 10-year rate available for Hong Kong the one-year interbank rate is employed.

all tests, can be found in appendix 1. The choice of monthly data was based on weighting the pros and cons of using high frequency versus low frequency data. Kasa (1992) refers to the finding of Shiller & Perron (1985) that the power of unit root and cointegration tests is primarily a function of the length of the time period, not the number of observations. However, using very low frequency data would reduce the size of the sample significantly, introducing small-sample biases into our results. Moreover, low frequency data may miss potential financial market interactions present in higher frequency time series. Monthly data would allow us to uncover cointegrating relationships where they exist, while having an adequate number of observations for estimation.

Furthermore, the standard deviation of stock prices, earnings and interest rates is calculated and presented in appendix 2. Comparing the high volatility of stock markets to the lower volatility of the two exogenous variables, we can infer that in the short-run the market is seldom "fairly priced". Therefore, we use an ECM, which abstracts the short- and long-run information in the modelling process to estimate the market's dynamic adjustment around the equilibrium value.

Methodology

It is by now well documented that a number of economic variables can move in tandem over long-term periods, while various dynamics can take place in the short-run. The important idea is that there is a "reversion force" that ensures the series will come back to equilibrium. Thus, the concept of cointegration is well suited to modelling such cases. If market valuation is driven by its fundamentals then one should expect that those series should be "cointegrated". Yet, in the short-run the market may deviate from this "fair" valuation since investors will constantly revise their expectations about the required risk premium.

Cointegration is a statistical concept, pioneered by Granger (1983, 1986), Granger & Weiss (1983) and Engle & Granger (1987)[5]. In general terms, two variables are said to be cointegrated when a linear combination of the two is stationary, even though each variable is non-stationary. Although cointegration identifies equilibrium relationships between variables, it tells us nothing about the dynamic adjustment to the long-run trend. If cointegrating relationships exist among a set of integrated variables, then according to the Granger Representation Theorem there also exists a dynamic error correction representation of the data. It is in fact the error correction model (ECM), which permits long-run components of variables to obey equilibrium constraints while allowing short-run components to have a dynamic specification.

Therefore, if two variables, P and V, are cointegrated with a cointegrating vector d, then they can be written in an ECM form:

$$\Delta P_t = c + \sum_{i=0}^{n} \beta_i \Delta V_{t-i} + \sum_{j=1}^{k} \gamma_j \Delta P_{t-j} + \delta \left(P_{t-1} - dV_{t-1} \right) + \sum_{n=1}^{m} \theta_n \Delta Z_{t-n} + u_t \tag{3}$$

where Pt-1 - dVt-1 is the error correction term. This is the standard ECM discussed by Currie (1981) and Salmon (1982) and has the usual interpretation that a change in Pt is due to the immediate 'short-run' effect from the change in Vt, momentum effects from changes in the past value of the dependent variable, additional changes in exogenous factors ΔZt, and the last period's error (based on the cointegrating regression) which represents the 'long-run' adjustment to past equilibrium. The practical implication of this is that the spurious regression problem is resolved. The above model is fundamental to the hypothesis tested in this paper.

5 5 The proposed methodology is preferred to the Johansen methodology because of its simplicity and the fact that the two stages directly formalise the intuitive notions of long-run equilibrium and short-run deviations. Furthermore, the Johansen approach is extremely sensitive to slight specifications.

IV. Empirical Results

In this section equation (2) is estimated by performing regression in levels and then employing the error correction representation where cointegrating relationships are detected to model deviations of the market from its fair value. Findings of cointegration and valid ECMs are the necessary elements for accepting the model as an adequate representation of stock market movements.

Unit root tests

Before proceeding with formally testing the model, we first try to determine the time series properties of stock market prices, earnings and long-term rates using the augmented Dicky-Fuller (ADF) test. The detection of a unit root in the level of each series necessitates the calculation of first differences and then these series are checked for the presence of a unit root. The results of the unit root tests appear in the table 1 below.

Table 1: *ADF unit root test in first differences*

	Indices	Earnings	Yields
Australia	- 12.83	-5.60	-11.62
Belgium	-9.28	-12.49	-11.28
Canada	-16.41	-13.20	-14.38
Denmark	-8.54	-8.54	-4.71
France	-11.84	-11.86	-5.86
Germany	-13.96	-13.02	-11.89
Hong Kong	-12.86	-2.89	-4.50
Ireland	-6.48	-13.80	-12.00
Italy	-12.71	-11.39	-12.93
Japan	-12.15	-2.11	-8.11
New Zealand	-5.99	-4.20	-9.21
Norway	-11.83	-12.91	-7.61
Spain	-11.19	-13.0	-10.74
Sweden	-11.61	-7.11	-10.88
Switzerland	-9.86	-8.36	-6.23
UK	-11.59	-11.52	-11.62
US	-14.97	-4.49	-15.57

All values reject the null at the 5% level of significance.

When examining stationary and non-stationary time series, the need to test for the presence of unit roots in order to avoid spurious regression is vital. In simple terms the null implies that the series is nonstationary. All series in levels reject the null in favour of the alternative and the test is reapplied in first difference form where all series accept the null hypothesis. Additional tests using other methods were also performed showing conformity with those reported above[6]. A maximum lag structure of 12 is chosen for the ADF tests, as the frequency of the data is monthly. The appropriate lag structure has been indicated by the minimum value of the Akaike or Schwarz information criteria.

Cointegration analysis

Having confirmed that all series have the same order of integration, we apply cointegration analysis to assess the validity of the suggested model. The proposed relationship of equation (2) is examined, and the residuals from the regression tested for the presence of a unit root. The results of cointegrating regressions and stationarity tests are given in Table 2 below. The results clearly show that cointegrating relationships are detected mostly in the stock markets of Australia, Belgium, France, Germany, Ireland, the UK and the US. For these markets, the ADF value from the stationarity tests on the residuals exceeds the 95% critical DF value. Weaker evidence for cointegration is obtained in the markets of Sweden and Switzerland. By and large, the results validate the unconstrained form of equation (2). Coefficients are highly signific–

[6] [6] Dickey & Fuller (1979) propose the DF test, testing the null that a series contains a unit root, and the ADF test in case the errors are autocorrelated. Sargan & Bhargava (1983) propose the CRDW test based on the usual Durbin–Watson statistic. Phillips & Perron (1988) developed a nonparametric test based on the Phillips (1987) Z–test, which involve transforming the test statistic to eliminate any autocorrelation in the model. There are also more recent tests that testing the null that a series is stationary Khan & Ogaki (1992).

ant, have the correct sign, and are consistent in size. In particular, earnings have a positive effect on stock prices, while the impact of market yields is negative[7].

Table 2: *Cointegrating regression*

$$\ln(P_t) = \alpha + \beta_1 \ln(E_t) + \beta_2 y_t + u_t$$

Country	α	β1	β2	Unit root
Australia	5.05	0.62	−1.11	−5.20*
	(36.43)	(17.93)	(−26.72)	
Belgium	3.80	0.89	−1.24	−4.07*
	(24.17)	(24.01)	(−17.44)	
Canada	5.67	0.47	−1.72	−2.84
	(38.77)	(13.29)	(−25.02)	
Denmark	6.00	0.47	−1.33	−1.10
	(28.80)	(12.68)	(−11.98)	
France	3.38	1.03	−1.41	−4.19*
	(14.50)	(21.34)	(−17.22)	
Germany	3.23	1.02	−0.77	−4.57*
	(27.51)	(37.99)	(−7.63)	
Hong Kong	2.74	1.08	−0.79	−2.15
	(18.87)	(34.74)	(−7.28)	
Italy	7.00	0.26	−1.22	−2.42
	(17.86)	(3.23)	(−12.78)	
Ireland	1.86	0.71	−1.33	−4.15*
	(69.02)	(14.57)	(−10.04)	
Norway	5.18	0.57	−1.66	−2.88
	(18.70)	(9.35)	(−17.28)	
Sweden	5.64	0.68	−1.64	−3.58**
	(27.90)	(19.28)	(−14.62)	
Spain	5.30	0.34	−1.38	−3.29
	(25.46)	(4.92)	(−19.30)	
Switzerland	4.00	0.90	−2.24	−3.62**
	(16.05)	(15.06)	(−11.86)	
UK	4.44	0.91	−1.43	−4.34*

[7] This is consistent with previous studies by Saunders & Yourougou (1990), Yourougou (1990), Dinenis & Staikouras (1998, 2000).

	(18.18)	(20.65)	(–16.20)	
US	1.47	1.13	–1.02	–3.69*
	(21.71)	(29.34)	(–16.01)	

t statistics in parentheses.
**Rejection of the null hypothesis of no coint. at the 5% level of significance.*
***Rejection of the null hypothesis at the 10% level of significance.*

Earnings elasticity in the markets where cointegration was detected varies from 1.13 in the US to 0.68 in Sweden, being higher predominantly in the traditional big markets. Having a closer look at these markets, such as France, Germany, the UK and the US, we see that the average sensitivity to earnings is 1.02. What the results actually imply, as a whole, is that a 15% change in earnings will result, on average, in a change of 15% in the markets' "fair" value[8]. Harasty & Roulet (2000) interpret a similar finding as "over an entire interest rate cycle, stock market prices are determined solely by earnings". Earnings have a weaker effect in smaller markets such as Australia, Belgium, Ireland, Sweden and Switzerland, where a 15% change in earnings will result, on average, to a 11.4% change in their value. This may be because these markets have "lagged" their fundamentals but have the potential to "catch up" in the future. However, it may well be the case that these markets are actually driven by larger markets (leaders) implying an influenced by external factors. The latter will be looked at in detail in the next section.

Interest rate coefficients seem to be 1.5 times more volatile than those of earnings. Their semielasticities vary from 2.24 for the Swiss market to 1.02 in the US. Assuming a volatile interest rate environment, then a 100 basis point change in market yields will cause, on average across markets, a correction of 1.35% in their "fair" value. Another point worth noting is the magnitude and the significance of the constant term. Based on our original assumption the constant should be close to $ln(1+g) + ln(k)$, but higher

[8] The fair price to earnings ratio is stable when interest rates are constant.

values are obtained. This may have been due to bubbles experienced by developed markets in the past two decades. Having analysed the cointegrating relationships it is natural to examine the short-term deviations and this is what we turn to next.

V. Short–Run Dynamics & Causality Effects

The second phase of the analysis involves modelling the short-run dynamics of the cointegrated regressions identified in the previous section via the ECM presented by equation (3). The first difference of prices is regressed against a number of variables such as earnings, yields, the spread between short and long-term rates, the spreads between US (or Germany, for European countries) and domestic long rates, exchange rates (against the DM for European countries, the dollar for Australia) and the dividend yield; the above are expressed in first difference form. In addition, the one-period lagged value of the dependent variable is incorporated to capture any momentum effects, while a dummy variable is included in the regression to test for the presence of a January effect. Lagged values of the explanatory variables have been found to be insignificant. Following Hendry's general-to-specific methodology only the significant variables are included. The one-period lagged error term from the cointegrating regressions represents the correction of the previous deviation from equilibrium. The results of the ECM are presented in table 3.

Table 3: *Error correction models*

$$\Delta P_t = c + \sum_{i=0}^{n} \beta_i \Delta V_{t-i} + \sum_{j=1}^{k} \gamma_j \Delta P_{t-j} + \delta \left(P_{t-1} - V_{t-1} \right) + \sum_{n=1}^{m} \theta_n \Delta Z_{t-n} + u_t$$

Country	c	β_1	β_2	γ	δ	θ_1	θ_2
Australia	0.01	0.16			–0.04	–0.12	–0.17
	(2.91)	(5.72)			(–2.20)	(–2.24)	(– 15.72)
Belgium	0.00	0.19			–0.03		–0.28

	(2.67)	(4.42)			(–1.98)		(26.40)
France		0.43			–0.07		–0.27
		(7.80)			(–2.37)		(–21.83)
Germany	0.00				–0.03		–0.45
	(3.79)				(–2.02)		(–26.32)
Ireland	0.01	0.08			–0.02		–0.28
	(4.15)	(2.40)			(–1.79)*		(–30.23)
Sweden	0.01	0.15			–0.02	–0.08	–0.25
	(3.19)	(3.43)			(–1.76)*	(–3.89)	(–16.65)
Switzerland	–0.01	0.46			–0.05		–0.50
	(3.78)	(5.56)			(–2.17)		(–18.62)
UK		0.84	–0.14	0.18	–0.04		–0.14
		(23.65)	(–1.97)	(1.99)	(–1.92)*		(–6.98)
US	0.00	0.32			–0.02		–0.30
	(3.14)	(5.21)			(–2.07)		(–28.18)

t statistics in parentheses
**significant at the 10% level*
c = constant
β_1 = coefficient of first difference of log earnings (V_1)
β_2 = coefficient of first difference in long–term yields (V_2)
γ = coefficient of one–period lag of the first difference of stock market prices (ΔP_{t-1})
δ = coefficient in the one–month lagged residuals from the corresponding regression in levels
θ_1 = first difference of the exchange rate
θ_2 = first difference of the dividend yield on the country's index

Looking at the error correction models there are a number of interesting results. First the estimated models are well fitted as one can see from the graphs in appendix 3. In order to conserve space we show only the UK and German market although very similar fitted values have been obtained for the other countries as well. The ECM seems to explain more than 70% of the variation in prices and all the variables have the expected signs and are consistent in size. Second, the reversion force is significant in all countries. Therefore, we are able to identify Granger error correction representations between stock prices, earnings and market yields. The coefficients of the reversion force are quite low, indicating that the different markets are pretty sluggish; each month the markets correct only between 2% and 7% of the previous month's valuation gap. A rather weak reversion force coupled with momentum (significant γ) in the case of the UK suggests that bullish and bearish trends tend to extend for a long time. Momentum is only detected in the UK, suggesting that a 1% rise in the market one month causes a 0.18% rise in the market in the following month.

The markets react immediately and positively to changes in earnings, with varying sensitivities. The coefficients are bigger on the whole in the largest markets - France, UK, US - which thing accords with the fact they also exhibit bigger coefficients for earnings in the "levels" regression. Surprisingly, changes in domestic earnings do not appear to affect market movements in Germany. Changes in long-term rates only affect the UK market, while no market is affected either by the spread between long and short rates or the spread between domestic long rates and German rates (US long rate for Australia). Exchange rate changes are only significant in two countries, whereas the January effect has no significant impact in any market. Finally, all markets drop if dividend yields rise (biggest drop in Switzerland, smallest in the UK), possibly due to signalling a lack of future investment opportunities.

Finally, we employ the Granger causality tests to investigate whether the smaller impact of earnings on the stock market index in the smaller markets is due to external influences from more dominant markets such as the US, the UK, France and Germany.

That is to say we test whether the larger markets Granger cause the smaller ones (size effect) and vice-versa. Granger causality relies on the principle that the cause should come before the effect and therefore implies the existence of a time lag. We provide below a simple example for testing Granger causality in the context of a bivariate VAR model:

$$Z_t = B' Z_{t-1} + U_t \text{ where } Z_t = (Y_t, X_t)'$$

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{pmatrix} \begin{pmatrix} Y_{t-1} \\ X_{t-1} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} \quad (4)$$

Granger noncausality can formally be characterized as follows. If $\beta_{12} = 0$ then the variable X_t does not Granger cause variable Y_t (where β_{12} is the estimated coefficient of a bivariate model). Similarly, if $\beta_{12} = 0$, then Y_t does not Granger cause X_t. Moreover, if X_t causes Y_t and Y_t causes X_t then the process $Z_t = (Y_t, X_t)'$ is called a feedback system. Granger causality tests are performed with stationary variables as in that case test statistics are assumed to have a standard X^2 distribution. Therefore, we examine causality among the log returns of the market indices between 1985 and 2000. Ideally, we would like a model to have lower values of the Schwarz or Hannan & Quinn information criteria as compared to an alternative model. We start with a maximum lag of five and start gradually to decline in order to ascertain the validity of the restrictions. In all time series of we are able to accept the restrictions on the VAR order of one lag. A likelihood ratio test has also indicated the choice of a VAR(1) model. The values of the likelihood ratio test under the null hypothesis of non-causality are reported in the table below. The arrows represent the direction of causality, and the numbers above are the chi-squared statistics with one degree of freedom.

Table 4: *Granger causality tets*

	US	UK	France	Germany
Australia	← 3.25**	← 79.64*	← 8.93*	← 2.35
	1.17 →	5.42* →	0.17 →	0.02 →
Belgium	← 3.60**	← 96.18*	← 0.03	← 0.35
	0.29 →	1.88 →	4.79** →	6.88* →
Ireland	← 10.29*	← 127.8*	← 5.16*	← 1.55
	2.02 →	3.44** →	13.44* →	7.69* →
Sweden	← 5.93*	← 69.08*	← 2.17	← 1.50
	1.96 →	7.45 →	3.27** →	5.84* →
Switzerland	← 4.19*	← 107.13*	← 0.07	← 1.44
	0.01 →	0.78 →	1.90 →	0.72 →

**Rejection of the null hypothesis of non–causality at the 5% significance level.*
***Rejection of the null at the 10% significance level.*

In general, there is no clear–cut evidence of a size effect running from large to small markets. Even though the US and the UK seem to Granger cause the smaller markets, some feedback systems with the smaller markets seem to exist, particularly in the case of the UK. Only for Switzerland is uni–directional causality, originating from large markets, detected. Instead, the increased market interactions accompanying glabalization since the mid–1980s are manifested either as feedback systems or uni–directional transmission mechanisms between different markets (causality running from both large to small markets and vice–versa). Therefore, interpreting the fact that smaller markets exhibit lower earnings coefficients than larger markets as evidence of causality running from market leaders to the more peripheral markets is not entirely legitimate, since smaller markets also seem to Granger–cause the so–called leaders. Instead, a possible interpretation might involve a combination of external influences from larger markets, and smaller markets having “lagged” their fundamentals in the past, with the possibility of “catching up” in the future. The findings of Granger causality between markets carry implications for portfolio diversification. If shocks are transmitted from market to market, then long-term investors will not be able to diversify by investing in different markets. Granger causality implies co-movement, the economic relevance of which depends on the speed of adjustment towards the common trend. If deviations from the underlying trend path are highly persistent, then a finite-horizon investor should attach little significance to the common trend.

VI. Conclusion

This study has presented evidence, which suggests that the earnings based valuation model is valid for describing stock market movements. Market indices are cointegrated with earnings and interest rates, at least in the major markets, while the error correction representation of the long-run regression, enriched with other variables that have been identified in previous research, seems to capture quite well short-term deviations from the fair value. The ECM incorporates the long-run information present in the cointegating regression and, thus, is a more efficient method to use compared to other studies, which miss the long-run information present in stock prices by modelling stock returns.

Granger causality tests do not invariably support that the smaller markets have lower coefficients due to external influences from dominant markets, but there are interactions between markets in both directions (large to small and small to large), and the smaller coefficients detected may be more due to the small markets having "lagged" their fundamentals. Most importantly, in the ECM a small negative but significant coefficient is detected on the lagged error term of the "levels" regression, which suggests a slow return to the fair value obtained with the long-run regression. This finding supports our choice of econometric methodology used to model the various stock markets, since cointegration implies and is implied by the existence of an error correction model. Therefore, the way in which we employ the earnings based valuation model to explain stock market movements, as fluctuations around a stochastic trend, has proved intuitive.

The approach used in this study could be appealing to market participants because the concepts of long-run fair value and short-run deviations formalize the intuitive vision investors have of the functioning of financial markets. The long-run regression confirms the correlation between the market and its fundamentals, quantifies this relationship, while the error correction process sheds light on additional variables that have an impact in the short-run. An interesting extension to this study might be to evaluate the out-of-sample forecasting power of the ECM with respect to stock market indices.

APPENDIX 1

Details of the index sample employed

Country	Approximate number of stocks per index	Starting date*
Australia	160	1985 M1
Belgium	90	1984 M1

Canada	250	1984 M1
Denmark	50	1990 M2
France	200	1987 M1
Germany	200	1984 M1
Hong Kong	130	1986 M4
Ireland	50	1986 M6
Italy	160	1987 M1
Japan	1,000	1984 M1
Norway	50	1985 M2
Spain	120	1987 M3
Sweden	70	1984 M1
Switzerland	350	1989 M5
UK	550	1985 M1
US	1,000	1980 M1

**stands for the month that each index has available data.*

APPENDIX 2

Calculated standard deviations

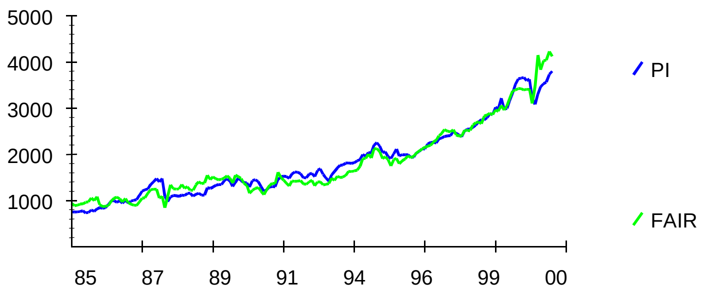
Country	Price Index	Earnings	Long–term rate
Australia	36.01	26.16	25.75
Belgium	47.26	31.17	23.10
Canada	52.04	34.70	24.09
Denmark	44.34	42.92	24.56
France	55.68	27.58	24.91
Germany	55.10	42.81	19.51
Hong Kong	58.83	50.49	27.34
Ireland	65.84	49.98	26.37
Italy	46.16	26.02	27.36
Japan	28.25	22.59	41.76
New Zealand	27.98	19.46	28.32
Norway	56.27	39.11	31.90
Sweden	88.65	65.08	28.09
Spain	51.47	22.42	25.68

Switzerland	57.49	39.52	28.93
UK	43.40	29.20	18.66
US	85.00	45.82	39.43

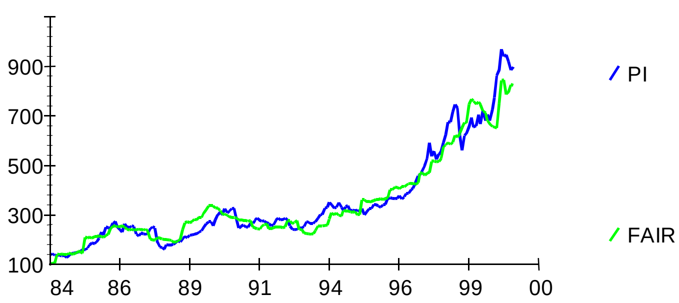
APPENDIX 3

Prices Versus Fair Values

UK Price Index and Fair Value



Germany Price Index and Fair Value



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